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SILICON CHIP

OCTOBER 2010
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THREE WORLD-BEATING PROJECTS:

32-Channel Music Lighting Sequencer/ Controller

SENSATIONAL Christmas Light displays . . . and any other lighting extravaganzas!

GPS BOAT COMPUTER

Tells you:

- Current position
- Current direction
- Current speed
- Current fuel use
- Navigate way home
- Find fishing spots
- Time and ETA

... and much more!

DIGITAL DAB+ & FM STEREO TUNER

Easy-to-build DAB+ & FM Stereo Tuner with exemplary performance – much better than 99% of commercial DAB+ receivers and tuners!

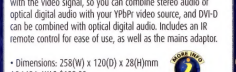
JOTA/ JOTI 2010: "The right to be heard"

jota joti
Right to be heard
53rd On the Air Sur les Ondes
JAMBOREE
14th On the Sur Internet
16 - 17 OCTOBER / OCTOBRE, 2010

Spring Clean SALE

HDMI 3-Port Switch

This system expander will allow you to hook up, convert and switch between a component video (YPbPr), DVI-Digital, and a HDMI signal to one HDMI v1.3 output. Audio is also combined with the video signal, so you can combine stereo audio or optical digital audio with your YPbPr video source, and DVI-D can be combined with optical digital audio. Includes an IR remote control for ease of use, as well as the mains adaptor.



- Dimensions: 258(W) x 120(D) x 28(H)mm

AC-1684 WAS $199.00

$129.00

SAVE $70.00

15 Piece Micro Driver Set

This handy set will fit the bill for all those microscopic fasteners. The ergonomic handles are colour coded for easy identification and they come in a sturdy storage case.

The set contains:
Slotted: 1mm, 1.4mm, 1.8mm, 2.4mm
Phillips: #000, #00, #0, #1
Torx: T5, T6,T7, T8
Hex: 1.5mm, 2mm, 2.5mm
Drivers: 105mm long
Case size: 192(L) x 130(W) x 26(H)mm
TD-2069

$24.95

Adjustable Holesaws

Installing wall and ceiling speakers or recessed lighting is now a lot easier with this unique adjustable hole saw. The saw is designed to cut through plasterboard and ceiling tiles and features calibrated adjustments to make hole size selection a breeze. The blades are carbide coated and self sharpening. Two sizes are available.

62 to 177mm hole size
TD-2520 Was $69.95
Now $36.95 Save $33.00
158 to 264mm hole size
TD-2522 Was $79.95
Now $44.95 Save $35.00
Note: Drill not included

MP3 Active Desktop Speaker

This little four speaker beauty is the ideal way for you to listen to your MP3 or iPod® Shuffle music without the need for headphones.

- Recharges iPod® Shuffle
- Total Power 2 + 2 W
- Plugpack included
- Measures: 105(L) x 105(H) x 60mm(D)mm

XC-5188 WAS $59.95

$34.95

SAVE $25.00

Rotary Tool Kit with Flexible Shaft

Flexible shafts have a multitude of uses. The kit consists of a powerful 32,000 RPM rotary tool that you can use with numerous attachments in the usual way, plus a 1m long flexible shaft that attaches in seconds to give extra versatility. Suitable for model making, automotive, workshop, art, jewellery or sculpture.

- 135W
- Over 200 accessory pieces
- See website for full kit contents
- Size: 210(L) x 52(Dia)mm

TD-2459

$44.95

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Displays the temperature and humidity together on the one huge LCD. It also has a min / max function (memory).

- Temperature: -10°C to 60°C / 14°F to 140°F
- Humidity: 10% to 99%
- °F/°C switch
- Low battery warning
- AAA battery supplied
- Size: 110(H) x 100(W) x 22(D)mm

QM-7202 WAS $39.95

$22.95

SAVE $17.00

Bargain ABS Cases

These tough ABS cases are ideal for transporting equipment and will protect valuable items from transit damage. Although not water tight each has a soft plush foam insert with pre-cut squares that can be removed to snugly fit the item you want to protect. Ideal for protecting your tools! Limited stock.

ABS Instrument Case MPV4
HB-6393 $49.95
ABS Instrument Case MPV7
HB-6395 $64.95

Extremely low price! Hurry while stocks last!

Desoldering Braid Dispenser Gun

An integrated desoldering tool for service and production work. Saves time and money by reducing waste.

- ESD safe
- Safer - no more burned fingers

NS-3042 WAS $79.95

$44.95

SAVE $35.00

Roll-Up USB Chess Game

Play against the computer or a real opponent. The game can also suggest moves and hints if you need a bit of help. You can even pause or save the game and come back later. Software included.

- 3 skill levels
- Board measures 260mm square

GE-4094 WAS $59.95

$19.95

SAVE $40.00

12VDC Voltage Polarity Easy Tester

new

A passive, quick and easy testing solution that performs five essential tests in the field: voltage, load, polarity, voltage drop and continuity. The load applied is selectable between 1A or 500mA to test wiring depending on location, device to be tested, and anticipated voltage drop. The illuminated power connector clearly displays polarity. Ideal for CCTV and security installers, car audio, roadies, AV techs etc.

- Dimensions: 51(L) x 44(W) x 29(H)mm

QP-2215

$24.95

LED Screwdrivers with 10 Bits

LED illuminated bit driver for working in spaces with poor lighting. The handle has four LEDs built in to provide working light. 10 bits are included, but any standard hex bit will fit. Great for fiddling around under the bonnet etc

- Four LEDs to eliminate blind spots
- Bits included: PH #0, #1, #2, slotted 3, 4, 5mm, T15, M6 pin drive, M4 hex, hex - 1/4" square converter
- Batteries included, plus a spare set

TD-2091 WAS $22.95

$14.95

SAVE $8.00

Rechargeable Solar DMM

An environmentally friendly DMM with rechargeable batteries that can be charged from the built-in solar panel, 12-36VDC or from mains power. Never have to buy batteries again.

- Category: Cat III 600V
- Display: 2000 count
- Size: 179(H) x 88(W) x 39(D)mm

QM-1546 WAS $119.00

$95.00

SAVE $24.00

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www.jaycar.com.au

Prices valid until 23/10/2010. While stocks last. No rainchecks. Savings are based on ORRP.

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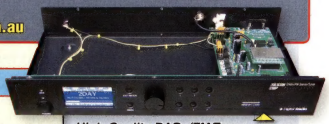
Vol.23, No.10; October 2010 www.siliconchip.com.au



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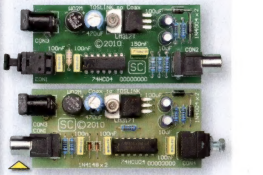

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Publisher's Letter

Letter to the Australian government

By the time you read this, the new Australian government should already have had its first sitting in parliament. And whether you voted Labor or otherwise, it is likely you will be watching the results in the hope that they don't have the same farcical initiatives as in the first term. We don't want another roof insulation debacle – that one will take many years before all the hitherto unforeseen consequences have occurred.

Nor do we want radical legislation to address the effects of global warming which are becoming less certain as time passes. Regardless of which argument you believe, there seems little reason for Australia to take expensive measures to make very small reductions in our national carbon dioxide emissions.

Of course, there are many people who believe that we should "give the planet the benefit of the doubt" and take action before it is too late (some climate scientists already think it is too late!). But rather than "putting a price on carbon" or establishling an emissions trading scheme (ETS), there are practical initiatives which the government could promote, particularly with an eye to reducing our long-term dependence on coal and petroleum. These would have the effect of providing significant benefits while also reducing carbon dioxide emissions.

First of these is to provide significant backing for research and development of Australia's potential geothermal (hot rocks) resources. Admittedly, some development is likely because of recently announced changes to the Renewable Energy Target Scheme (RETS) but it needs a much bigger push if we are going to get viable commercial development within the next 10 years. At the moment, while there are a number of listed companies which are working in this field, no-one really knows whether it will work.

Second, and nothing to do with electricity generation, there should be concerted action to move Australia's transport industry away from its dependence on diesel and petrol fuels, to compressed natural gas. As each year goes by, Australia has to import increasingly greater quantities of diesel and petrol and it is already a major import cost. By contrast, we have truly abundant reserves of natural gas and we should be looking to use much more of this to run cars, trucks, buses etc. Not only would this have the effect of securing Australia's transport fuel needs far into the future but it would also lead to very substantial reductions in our carbon dioxide emissions.

This would be far more efficient than the current promotion of very expensive so-called renewables such as wind and solar power. Nor, on present developments, are electric and hybrid electric vehicles likely to make much of a dint in our carbon emissions. So rather than providing substantial subsidies to the production of hybrid electric vehicles, as in the case of the Toyota Camry hybrid, the government should realise that we are going to continue driving our petrol and diesel vehicles for many years to come. Compressed natural gas should be the answer – cheaper fuel in the long run, less pollution and less carbon dioxide emissions.

What are we waiting for?

Leo Simpson

Integrate Touch Sensing Quickly and Easily

With Microchip's Range of Low Power, Low Cost Solutions

Microchip's mTouch™ Sensing Solutions allow designers to integrate touch sensing with application code in a single microcontroller, reducing total system cost.

Microchip Technology offers a broad portfolio of low power, low cost & flexible solutions for keys/sliders and touch screen controllers. Get to market faster using our easy GUI-based tools, free source code and low-cost development tools.

Touch Sensing for Keys and Sliders

- **mTouch Capacitive Sensing technology**
  - Longer battery life with eXtreme low power MCUs; Capacitive Sensing in less than 5 µA
  - High noise immunity and low emissions
  - No external components
- **mTouch Inductive Sensing technology**
  - Use polished or brushed metal surfaces including stainless steel and aluminum
  - Sense through gloves
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  - 8, 16 & 32-bit PIC® MCUs for Capacitive and Inductive Touch
  - Integrated USB, Graphics, LCD, IrDA, CAN

Touch Screen Controllers

- Fully processed touch coordinates
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  - Low cost MCU implementation
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  - Low operating current 1.5 mA at 5V typical
- **Analog Resistive technology**
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MICROCHIP

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Thanks for articles on hearing loops

Thank you for the article on hearing loops in the September 2010 issue. I had no idea they were so different to what I had guessed at.

This town has a fairly good theatre, with good but not excellent natural sound. I have severe hearing problems, so was pleased when a loop was installed. However, if I wanted to hear (via hearing aids) the audio on the loop at the first performance I attended after the loop was activated, I found it necessary to point my face to the side of the stage, then turn my eyes without turning my head to see the action at the middle of the stage. Pointing my head towards where my eyes naturally looked gave a null.

I mentioned this to the staff and they denied the possibility but after a few weeks the system performed as I would expect it to. I cannot explain this fault which apparently was corrected.

This town is in the throes of a major road re-build, together with two bridges at the ends of the piece of road, about a kilometre long. Temporarily, street lights have been installed which are solar-powered. Some people wrote to the local newspaper, suggesting that all street lights should be solar powered, thus costing us nothing to run. A practical accountant or business manager should be able to understand the fallacy but I doubt if it could be explained.

Alan N. Brooks,
North Mackay, Qld.

Comment: lay people usually assume that solar power is cheap since it is powered by the Sun. If only that were true. Then it would make sense to get rid of all coal-fired power stations.

QUAD review should have avoided subjective tests

Thanks for the great write-up on the QUAD equipment in the August 2010 issue. As a long-time audio enthusiast I find these sorts of articles very interesting and more would be very welcome if the opportunity arises. I would be very pleased to end up with a set of QUAD equipment that was in as good condition as this collection appears to be. The descriptions and tests and comparisons were really good, however I would like to make some comments.

The primary question in the article is "How would the legendary QUAD system compare to the best audio equipment today? Did it deserve its reputation?" The question really has two parts:

Part A – "Did it deserve its reputation?" If we were to answer that we would have to go back in time and make some assessments of the QUAD versus its contemporaries and that would be hard. I think it's fair to say that it did deserve its reputation as it offered reliable, high-performance

Toyota engine runaway – a first-hand account

When I first read reports about the uncontrolled engine runaway problems in certain models of Toyota motor cars, I must admit to being somewhat sceptical. But having experienced the problem twice, as a passenger, I now believe it is true.

Early reports suggested that only the Toyota Prius vehicles sold in the USA were affected but further reading indicates that some other Toyota models also suffer from the problem.

My experience happened in Sweden, with my brother-in-law driving. The vehicle, purchased in Denmark, is a Toyota Urban Cruiser, manual diesel, no cruise control, about 5 months old, 11,000km "on the clock" and at a guess, with 250 hours total running time.

In the first incident, the driver pressed the brake pedal to slow down in traffic and the engine started pulling strongly. The driver then pressed the clutch pedal, engine revs went up to "redline" whereupon the driver pulled to the side the of road, stopped the car and then stopped the engine; no real drama. He then restarted the engine after about a minute and all was normal.

The second incident happened about 20 minutes later when he had to stop for traffic ahead. The driver pressed the clutch pedal, then the brake pedal to stop when the engine red-lined again. He stopped the engine and immediately started it again. Again the engine red-lined, was stopped again and restarted after about a minute, after which all was normal.

We phoned Toyota in Denmark, who arranged for the car to be checked by a major Toyota Agent in Gothenburg, Sweden. After a full analysis they found nothing wrong.

Interestingly, the car had never had an engine runaway problem prior to the incident and has been operating normally ever since.

The accelerator pedal was not caught by the floor mat or stuck open, nor did we carry an active mobile phone and I believe we can rule out "cosmic rays".

I can well understand how accidents can happen due to a sudden and unexpected engine runaway, particularly to cars with automatic transmission, driven by elderly or inexperienced drivers.

Poul Kirk,
South Guildford, WA.

Comment: your experience is interesting although we note that exhaustive tests in the US have failed to locate any software problems. We have also not heard of any such issues with models sold in Australia.

Rockby Electronics

SOLARKING Monocrystalline 12/24/36V Solar Panels

Monocrystalline solar panels are designed for long life (up to 20 years) and high efficiency output. These units may be ganged into arrays for applications where high power output is required eg for large battery banks. An excellent solution for remote or mobile power applications, electric fence battery banks, inverter systems, RV's, caravans, boats etc.
All aluminium frames and tempered glass panels allow installation in the most demanding environments.
To prevent moisture ingress, the solar cell modules are laminated between sheets of high transmissivity 3mm tempered glass, tedlarpolyester-tedlar (TPT) material and sheets of ethylene vinyl acetate (EVA).

Stock#	Max Power	Rated Voltage	Short Cct Curr.	Open Cct.	Dimensions LxWxH	Price
#36994	**10W**	12.0V	**0.56A**	22.0V	396 x 289 x 23	**$45.00**
#36995	**20W**	12.0V	**1.17A**	21.6V	645 x 295 x 25	**$89.00**
#36996	**40W**	12.0V	**2.28A**	21V	645 x 541 x 23	**$181.00**
#36997	**80W**	12.0V	**4.55A**	21.8V	1210 x 540 x 35	**$349.00**
#37873	**120W**	12.0V	**6.82A**	21.8V	1500 x 660 x 35	**$456.00**
#37970	**175W**	24.0V	**4.87A**	45.1V	1508 x 808 x 35	**$635.00**
#38653	**185W**	36.0V	**5.55A**	45.1V	1580 x 808 x 35	**$775.00**

Features:
*Heavy Duty Metal Frame
*20 Year Limited Warranty
*Monocrystalline Silicone
*3.2mm Tampered Glass

80W Folding Monocrystalline Solar Panel

In-built Controller for direct charging to battery

#38430

A convenient alternative energy solution for those on the move. Fold it away and store it in the carry bag when not in use, then when you set up camp just fold it out so your batteries are being charged. A stand is included so you can position the panel for optimum solar capture. Features alligator clamp connections on a 4m lead, has the charge controller included so you can connect directly to your battery without fear of over-charging, and is supplied with a durable nylon carry bag. Excellent for camping, 4WD, boating etc.

$475.60

Dimensions:
- Open: 1090(W) x 623(H) x 36(D)mm
- Folded: 545(L) x 623(W) x 73(D)mm

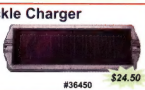
Solar Charger Regulators

Specifications:
Battery Voltage:12V
Open circuit Voltage:12V
Continous charge:20A
Maximum charge current:25A
Maximum load current:25A
Operation Current:30mA
Voltage across terminals(PV to Battery):0.8V
Voltage across terminals (Battery to Load):0.4V
Recommended wire size:#12 AWG
Dimension (WxHxD): 150x85x45mm
Operating Ambient Temperature:-10-50°C

#36998	**20A**	12V	**$89.80**
#38179	**30A**	12V	**$115.50**
#38238	**20A**	24V	**$119.30**

12VDC Solar Battery Trickle Charger

Lead acid cells will self-discharge, even when completely disconnected, if they are not re-charged regularly, eg. when a car is not driven for long periods or on a boat which is used infrequently. Includes suction cups for mounting to inside car windows, alligator clips and cigarette lighter adaptor lead.



#36450 ***$24.50***

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Features:
* Digital Tuner
* LCD TV Colour screen
* strength and quality readout
* live digital picture
* built in speaker
* 2.5 hour battery life
* lithium ion 1950mA battery
* Pal female 75Ohm input connector
* Fully DVB MPEG-2 compliant

Includes:
* 240v Charger
* Carry Case
* 12VDC cable
* USB cable
* Strap

#38126

Specifications:
Frequency range: 174 Mhz ~ 820 Mhz
Signal level: -65dBm ~ 25dBm
Video format: PAL/ NTSC
Guard Intervals: 1/4, 1/8, 1/16, 1/32
Modulation Mode: QPSK, 16/64 QAM
Size: 158x95x45mm
Manufacturer: Satking WS-6905

$196.00

SOLARKING 12V 110Ah GEL Deep Cycle Battery

Applications:
Solar and Wind Power Systems, Medical Equipment, Power Tools, Communication Equipment,
Emergency Power System etc.

Rating: 12V 110Ah/10hr
Technology:GEL
Weight:31.85kg
Size(mm): 329(L) x 171(W) x 220(H)mm
Manufacturer:Solarking

$288.00

#38698

CCD Vehicle Reversing Colour Camera

Housed in a weatherproof diecast enclosure, this tiny camera may be coupled with any in-vehicle monitor using a standard composite input. The compact size and integral mounting bracket allows mounting on rear bumper, number plate recess or even inside a hatchback or wagon. Video signal is mirrored as if you were looking in your cars rear view mirror.

$69.20

#38456

Specifications:
1/4" CMOS
Resolution: 420 lines
Video O/P: 1Vp-p 75 Ohm
Input Voltage: 12-15V DC
Dimensions(mm): 23 x 33
Focal Length(mm): 2.5
Light Sensitivity: 0.5 Lux

Green Energy Saving Powerboard

Attach main appliance (computer, TV screen) to the "master socket". When power to the appliance connected to this socket is turned off/on manually or by remote - the other four "slave" sockets are then turned off/on automatically. A sophisticated sensor circuit detects the level of current passing through the main master outlet and switches the slave outlets to the same status. This reduces the consumption of standby power used by computer peripherals and other equipment when not in use. This will save you money. One additional power socket will operate continuously and independently.

#36810

$39.00

Mains Power Meter

This mains power meter is designed to monitor your appliance devices power consumption in real time. The metercan display the instantaneous voltage or current being drawnby your devices.

$18.50

#38317

Measure voltage range: 190-276V AC
Measure voltage accuracy: +/-3%
Measure current range: 0.02-16A
Measure current accuracy: +/-3% or +/-0.03A
Measure power range: 0-4416W
Measure power accuracy: +/-5% or +/-10W
Accumulative electric quantity range: 0-9999.9kWh
Clock accuracy: +/- 1 minute per month
Power cost:: <2W
Battery: 2x1.5V LR44/AG13

Deluxe Ultrasonic Cleaner

Gently cleans CDs, DVDs, switches, relays, jewellery, glasses, watches, fuel injectors and other very fine parts. Suitable for CD & DVD cleaning. This ultrasonic cleaner uses a transducer generator to produce millions of microscopic cleaning bubbles which blow dirt, grease and grime off surfaces and penetrate deep into cracks and holes. This personal ultrasonic cleaner won't scratch precious jewellery or glass. Simply fill with water.The unit features a 125 x 148 x 45mm stainless steel tank with a capacity of 600ml. Features 1.5-8 minute digital timer with LCD readout. Not designed for continual operation.

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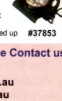

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Challenging repair job

The recent photo in the Mailbag pages (August 2010) of a badly corroded radio found in a creek reminded me of a job I did a little while ago.

While working on a vessel I found this amplifier located under the forward companion-way. Sea water had found its way into the amplifier and it seemed to be beyond repair. There were green spots where some copper tracks had been and several components were missing or badly corroded.

Still I persevered. With liberal application of alcohol to the PC board and replacing a couple of resistors etc, I managed to get it working again. The chassis responded well to a severe dose of grit blasting and a coat of paint. The mains transformer was shot but the amplifier

now works quite well from the ship's batteries.

I guess I'm a dinosaur because, rather than throw it away and put a new one in, I find it a challenge to repair items like this.

John Rich,
Petersham, NSW.

audio equipment that had a unique physical presentation and many aspects of the circuit topology used concepts and techniques that are still valid today ("Current Dumping" is one of those).

Part B – "How does it compare to the best audio equipment today?" While this is an answerable question using a few simple comparisons, it's only historically useful and not a reasonable basis to "bag" the equipment for your Serviceman. Let's have a look why.

The technical tests should have probably compared the ETI or EA designs of the same era to the QUAD as a counterpoint to today's equipment. I would be really disappointed if SILICON CHIP and its competent technical staff couldn't design amplifiers as good as the tests show. Equally, it's been possible for many years now to buy pre-built modules from various parts of the world which have stunning performance levels – I have purchased them myself.

Depending on the equipment that you look at, it is not hard to find consumer electronics equipment today that is technically a lesser performer than good equipment from years ago, as the emphasis has shifted from absolute performance to features like DSP (digital signal processing). All that aside, the pragmatic reality is that it's not possible to detect good and less good at the incremental differences we talk about here. It's all good.

There is no real validity in talking subjectively about major improvements in the sound obtained by driving the QUAD speakers with a different amplifier, etc. The only valid subjective test is a fully supervised double-blind test with statistical assessment to remove the observations of chance.

Nicholas is probably best advised to keep away from that as its like "Narnia and the Never-ending Story". I suggest that sort of uninformed rubbish be left to the popular press that has little or no technical know-how but a burning desire to sell loads of "pulp fiction".

Additionally, in a true double-blind test, it would not be possible to reliably detect the difference between the QUAD amplifier and the others as a discernible improvement, unless the auditors were smoking something illegal. Other journals and our small technical/audio group have demonstrated that a number of times over 30 years or so.

We should not forget the late Professor Ed Cherry's designs using NDFLs (Nested Differentiating Feedback Loops) which blitzed the known world 25 years ago or more and had THD figures at the 0.000n% level and were easy to build at home. There was an interesting review in ETI magazine some years back of a Pioneer amplifier that used NDFLs and one that didn't – both with the same model number.

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There is some history behind that test and the amplifiers and the rights to use NDFLs.

I would expect that the Serviceman will relax and enjoy some superb sound out of some beautifully-built audio equipment which is working well 40 years or so after it was made. Let's have more of these articles and keep up the good work generally.

Ranald Grant,
Bellbowrie, Qld.

Comment: there is no doubt that the QUAD equipment gave good performance in its day and certainly would have compared very well with other brands available at the time. The "current dumping" feature was a notable innovation because it gave low crossover distortion without the need for quiescent current adjustment during the production process.

As far as the subjective tests were concerned, the results were like "chalk and cheese", as stated in the review. Firstly, the general level of distortion from the QUAD 44/405 combination at normal listening levels (ie, not full power) was more than an order of magnitude worse than the SILICON CHIP Ultra-LD Amplifier (see the December 2001 issue for the performance plots). Secondly, the frequency response is much more extended at the extremes of audibility for the Ultra-LD. We were not hearing subtle differences; they were very significant.

And while double-blind tests are often touted as the only way to make a fair comparison between amplifiers and so on, in practice it is very difficult to ensure that you are only comparing differences in distortion rather than slight variations in frequency response or overall gain. Even differences in damping factor over the audio range can have a significant effect on the overall frequency response from a given loudspeaker system. Dialling these differences out, in preparation for double-blind test, is almost impossible.

Having said that, we agree that the emphasis on subjective assessments of sound quality in some so-called hifi magazines is unscientific.

We stand by all the statements in the review.

Accusations of Photoshop manipulation

The aerial photographs of the Sanctuary Cove Boat Show (SILICON CHIP, July 2010) are indeed correct, with many temporary floating walkways enclosing the numerous boats which are often brought from afar for this impressive display. I know as we have walked them many times.

However, at the risk of quite correctly being called a pedant, I note the photo used is not from at least the 2010 show. The Waterfront Tavern (the large diamond roofed building with the half tube on top) is present in the image when in fact it was demolished prior to the event. Also the boat mooring is quite different in the region where some friends had their display this year. A prize to the person who can pick the year? Keep up the great work with your excellent publication.

Kevin Roche,
Arundel, Qld.

Comment: most interesting. We brought this matter up with Kevin Poulter (author of the Sanctuary Cove story) and he admitted that he had

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used a previous year's photo because at deadline they had not released an aerial view and when it was released a few days later, it was not as good.

We will also admit to actually doing some Photoshop to the photo as well. If you do a Google Earth of Sanctuary Cove you will see that the water ain't blue. So there is a bit of guilt all round.

Energy savings have been understated

On the energy efficient lighting front you missed an important factor in your estimated savings in the article, "Slash your Factory/Office Lighting Bill" (SILICON CHIP, May 2010). Most offices are air-conditioned and in summer the efficiency when it is hot outside is at best 1:1. Any heat you can prevent from being generated as waste heat inside is an equivalent saving in cooling costs and at a later date, cooling-plant size cost.

Including this factor gives you a doubling in savings during summer which if it were hot the full three months would give you a 25% increase in savings for the year. I would expect more.

Norm McGeoch,
Hornsby, NSW.

Comment: as noted in the Publisher's Letter in the May 2010 issue, the effect of reducing the lighting power consumption probably won't have much effect on the air-conditioning, taken over the whole year. In summer it will probably reduce the cooling demand but the effect would reverse in winter when you need heating.

Since we changed over our office lighting to NEC quad phosphor fluorescent tubes, we have had one electricity bill but it only covers about one month during which the new tubes have been installed. We cannot identify any savings at this stage compared with the same period last year because this winter has been notably colder than for quite a few years and also the office hours have been increased due to some staff members starting earlier in the mornings.

On one point there is no doubt: we are paying much more for electricity, as are all consumers.

Microsoft Issues Warning On Phone Scam

Sydney, Australia: 26 August, 2010: Microsoft today warned Australians to be wary of a phone scam that has left some victims hundreds of dollars out of pocket. Scammers are using several well-known brands, including Microsoft, to fool people into believing that something is wrong with their computers. The scam typically unfolds in the following manner:

A cold caller, claiming to be a representative of Microsoft, one of its brands or a third party contracted by Microsoft, tells the victim they are checking into a computer problem, infection or virus that has been detected by Microsoft.

They tell the victim they can help and direct them to a website that then allows the scammers to take remote control of the computer.

The cold caller will then spend some time on the computer trying to demonstrate where the 'problems' are and in the process convinces the victim to pay a fee for a service that will fix the computer.

"In reality, there is nothing wrong with their computer but the scammer has tricked the consumer into believing there is a problem and that paying the fee is the best way to get it fixed. Often they will also push the customer to buy a one year computer maintenance subscription. They are just trying to scam innocent Australians out of money," said Stuart Strathdee, Microsoft Australia's chief security advisor.

Strathdee also said that the callers presented themselves in a professional manner and sounded genuine.

"Don't be fooled, Microsoft is not cold calling consumers in regards to malfunctioning PCs, viruses or any other matter," he said.

"We strongly advise Australians to simply hang up if they receive a call of this nature and not to respond to any communications from these scammers.

"If you're not sure, contact Microsoft on 13 20 58 or the police," he said.

Batteries for vintage radios

In regard to the query in "Ask SILICON CHIP" by T.V. from Mt Martha, Vic, a couple of D-size cells in parallel will do nicely for the 1.5V "A" battery. As for the 90V "B" battery, I suggest getting in contact with Tony Maher at

Tmaher@detection.com.au; phone (03) 9800 1825. He sells a 90V "B" battery DC-DC converter kit that runs from six AA cells in series (9V) for a reasonable price. I built one a while ago and it does a good job powering the Healing "Golden Voice" portable that I had restored.

A suitable power supply unit (which I also built) was published in Circuit Notebook (SILICON CHIP, November 1991) and a suitable DC-DC converter was published in the April 1993 issue of SILICON CHIP. I hope that T.V. has access to those issues.

Darryl Sampson,
Seaton, SA.

Second source for vintage radio batteries

With reference to the question by T. V., of Mt Martha in "Ask SILICON CHIP" in the August 2010 issue, regarding batteries for a vintage radio, Pro-Vision Electronics in Wodonga, Vic, has a product called the "Unipower". This comes in kit or assembled form and has two versions, one for 1.7A heaters and one for 5A heaters.

I and friends at Nostalgic Wireless have used these supplies with great success. The board has one adjustable "A" supply and five fixed "B" supplies (135/90/67/45 & 22V), as well as three adjustable "C" supplies. The board size is 100 x 105mm and uses switchmode operation. Pro-Vision can be contacted on (02) 6024 4558 or **provision@iinet.net.au**

Alternatively, if you have a selection of transformers available, there was a design by Peter Lankshear published in EA's "Discovering Vintage Radio", back in 1992. I built my version of P. L.'s design and it takes up a tad more space than the Unipower.

Bob Forbes,
Forest Hill, Vic.

Headphone adaptor could provoke security scare

Commenting on Robert Gott's letter "Audio Quality On Commercial Long-distance Flights" (Mailbag September 2010), many years ago my father built a simple battery discharger (light bulb, two wires and alligator clips) and took it with him on an overseas flight. Even at that time in the history of terrorism this device caused something of a stir at the x-ray machine.

These days, I believe anything that looked even remotely hand-made in carry-on luggage would cause major issues at check-in. I therefore feel a home-made adaptor box would at minimum be confiscated and might even cause the holder to be detained.

John Evans,
Macgregor, ACT.

SILICON CHIP kit marketing scam

Firstly, a big thank you to you and your team for a great magazine. I really enjoy reading SILICON CHIP and look forward to each new monthly issue. Secondly, a sad warning for you and your readers: I suspect your audience is now being targeted by online scammers

Mailbag: continued

Aircon use is driving electricity price rises

I read with interest your editorial in the August 2010 edition entitled "Big Business Is Driving The Push For A Carbon Price". Your assertion that electricity prices are going up due to "the lack of new power stations being built and the increasing subsidies being offered to costly renewable energy" is incorrect and these are not the major reason for recent price increases.

The Queensland electricity pricing regulator points out that the primary reason is "an increase in transmission and distribution costs" and explains the various components of the retail price increases (network, energy & retail) – see **http://www.qca.org.au/electricity-retail/NEP1011/finaldec.php**

The national regulator draws attention to "the need for increased investment is being driven by a greater use of air-conditioning" – see **http://www.aer.gov.au/content/index.phtml/itemId/728143**

This increase in air-conditioning has led to 13% of the Queensland grid (up from 8% just three years earlier) being used for just 1% of the year in 2008-09, ie, a large part of expensive grid capacity is needed on just the very hottest days: **http://www.energex.com.au/network/network_prices/pdf/Development%20of%20Network%20Tariff%20Structures_Discussion%20Paper_Final.pdf**

Renewable energy on the other hand is funded by the Renewable Energy Target. The retailers are the ones who must buy the RECs and then pass on the costs as retails costs. To a lesser degree, PV solar is also funded by the network distributors in the form of the Feed-in Tariffs (FiT) and these remain a tiny part of their costs.

I draw your attention to this error and hope you may publish my letter because I believe electronics enthusiasts should be the most informed members of the community.

Rob Farago, West End, Qld.

etc. I was searching this morning for a kit for the Dead-Accurate 6-Digit GPS-Locked Clock (SILICON CHIP, May & June 2009) and came across the following website: **http://www.basatek.com/Diy_Electronics/projecttopics/6%20digit%20clock.htm**

Supposedly they will supply me the complete kit for this project – from Nigeria. All I need to do is send them my contact details and credit card details.

Please feel free to correct me if I am wrong but the lack of acknowledgement of SILICON CHIP as the source of the project leaves me suspecting that any attempt to purchase a kit off these guys would leave me substantially poorer.

David Blake,
Hoppers Crossing, Vic.

Comment: thanks, David. The whole site is bogus.

5-watt resistor does not need a fuse

Reading Roy Flynn's diagram on using LED lights with brake warning lights and cruise controls (Circuit Notebook, July 2010), I found it an excellent idea but I feel there could be two little additions to overcome the problems he mentions at the end of his write-up.

Firstly, concerning the 5W resistor burning out if the relay fails, if you were to place a 2.5A slow-blow fuse in line with the resistor, the fuse would fail as well, causing the brake warning light to come on or cause the cruise to stop engaging, indicating there is a problem with the circuit. The resistor would draw 2.55A at 12V, increasing to 2.93A at 13.8V; using a slow-blow fuse would allow for the current drawn while the relay is energised.

Secondly, if you were to place a diode in line with the relay winding, it would drop the voltage by

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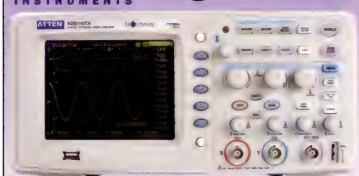

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0.7V, making the coil last longer. Once again, a great idea but these small additions make it a little safer.

Matt Bilston,
Rutherglen, Vic.

Comment: we do not agree with your remarks. You make an assumption that a 2.5A fuse will not generally blow for short periods of between 2.55A and say 3.06A when the relay contacts switch over. That is true. But you also assume that the fuse will blow at over 2.5A (2.55A to 3.06A) if the relay fails and allows current to continue flowing through the 4.7Ω resistor.

Considering the resistor will be dissipating at least 30W, it will fail almost immediately anyway and will go open circuit.

The fuse will not protect the relay. The fuse should be able to maintain the 2.55-3.06A current for between one hour to four hours should the resistor survive. And it is not likely the brakes will be applied for that long!

A fuse needs to have 200% of its rated current to blow in five minutes but 135% of rated current to blow in one hour and 110% to blow in four hours.

We also reject your recommendation to add a series diode for the relay coil. The specified relays are automotive types and are rated for the 14.4V that could be applied. A series diode would introduce a 0.7V reduction but this is insignificant and unlikely to increase coil life. It is usually the contacts (moving parts) that fail over time. The diode would reduce coil dissipation by about 10% when the battery voltage is 13V.

Haitz's Law predicts logarithmic LED improvements

I enjoyed September's SILICON CHIP article and editorial on developments in LED illumination but I was surprised that "Haitz's Law" was not mentioned. The celebrated "Moore's Law" (relating to the number of transistors on an IC doubling every 18 months) is well-known but an equivalent "Haitz's Law" for LED illumination is also now gaining credence.

American scientist Dr Roland Haitz put forward this law after observing that LEDs had been doubling in brightness every 18 months since they were first commercialised some 40 years ago, and that there seemed every expectation that this trend would continue. An extension to his "Law" predicts that purchase prices for the same LED illumination levels should decrease at a similar logarithmic rate.

Aside from obvious energy and maintenance savings, the march of Haitz's Law means building fit-outs and renovations should allow for the different illumination conditions and fixtures that may be the norm within five years.

LED lighting certainly looks the way of the future and compact fluorescent lamps may already have passed their "peak CFL" (pun intended) after a market life of barely a decade.

Stan Swan,
Wellington, NZ.

Heat gun mods may cause element failure

I wish to comment on Callum Martin's suggestion regarding the use of a heat gun and silicone tubing to solder SMD components (Mailbag, October 2009, page 5). Unless the heat gun is designed for such use, a supply of spare heating elements is advised. The restricted air flow will very quickly destroy the element. The gun is usually designed to operate with the attachments supplied with it without modification.

I write with some experience here as a similar situation occurred some years ago when a gun attachment was modified to heat Raychem solder sleeves with disastrous results for the hot-air gun. The solution is to obtain the correct tool.

Some of the catalyst type gas soldering tools (Weller, etc) have a hot-air function (no flame) which may be OK with careful adjustment of air temperature. These get extremely hot so great

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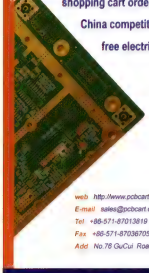

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Mailbag: continued

LED lamps have a lumpy colour spectrum

I found the LED replacement strip lamp article in the September issue of SILICON CHIP interesting but there was a glaring omission. You kept mentioning the necessity to make the comparison with a quad phosphor fluoro tube but never told us why the fluoro needed four phosphors in the first place.

I refer to the colour spectrum of the light produced by all lamps. Old incandescents have a continuous spectrum with no holes in it. Fluoros are made up with two, three or four phosphors which have specific colours and so there are dips and holes in the spectrum. LEDs have even narrower colour spectrums and it would be useful to know just how continuous the spectrum of these replacement LED strip lights is.

I also note that the downloadable datasheet from Tenrod does not contain any information on the smoothness of the LED's colour spectrum.

I've heard people complain that they can't read by the light of a CFL. Most likely this is due to its lumpy spectrum.

White LED torches are very bright but don't seem to visibly put out as much light as an old incandescent bulb torch. This would be due to the LED's spectrum being narrower than the incandescent's spectrum.

I will hazard a prediction that unless the white LED colour spectrum is made as continuous as the old incandescents bulbs, people will experience more headaches after prolonged use.

Gary Yates,
Belrose, NSW.

Comment: it is true that incandescent lamps have a continuous light spectrum whereas all other artificial light sources have dips and peaks in their spectral response. However, the spectral response of white LEDs is possibly better than that of incandescent lamps.

Incandescents typically have a notably orange "cast" since more of their light output is towards the infrared end of the visible spectrum. This is reflected in their colour temperature which is typically around 2700K to 3300K, depending on the operating temperature of their filaments.

White LEDs, on the other hand, have a much higher colour temperature, with emphasis on the blue end of the spectrum. This is hardly surprising since most white LEDs are essentially blue LEDs with accompanying phosphors.

White LED torches are now often much brighter than incandescent lamp torches. The reason why people may find it hard to read under CFLs probably has more to do with their uneven light distribution compared to incandescents.

care is needed when using them. I have not used mine in this application so please regard this as a suggestion only.

Bob Rayner,
Willow Vale, Vic.

Television Gladesville up in smoke

On 17th of June, the Sydney house of Keith Cunliffe, VK2ZZO and Matthew Magee, VK2YAP burned to the ground, with its entire contents destroyed. The building which was left smouldering and ruined also housed Television Gladesville, the studio and station of the Gladesville Amateur Radio Club.

For over 24 years, VK2TVG went to air several times a week on the amateur 70cm band (433MHz). The station disseminated information of all kinds relevant to radio amateurs and an interested technical audience, ranging from news, information, electronic theory courses, corporate technology videos and test material.

VK2TVG had also been broadcasting on UHF Channel 43, until the allocation was withdrawn as part of the digital roll-out. Part of the appeal of VK2TVG was its full broadcast quality and high broadcast production values. Recent technical developments included video streaming, a home-brew digital software standards

This photo shows the remains of the collapsed studio. The Ikegami 355 cameras partially survived but their camera control units were completely destroyed.

converter and plans to uplink on a satellite channel.

In the true spirit of amateur radio, the station thrived on experimentation, refurbishing old gear and pushing the envelope.

Fortunately, the house and personal effects were insured and the insurance investigators determined that a domestic appliance was the primary source of the fire, not any of the broadcasting equipment. Destroyed equipment included television cameras, audio gear, video recorders, graphics computers, monitors, studio lighting and the instrumentation and spares needed to keep a complete TV station on-air.

A major casualty of the fire was the tape library. Ironically, it was the library which apparently kept re-igniting for over an hour; as tightly-wound polyester tape is hard to extinguish. There was a lot of that, being a vast library of scientific and technical documentaries and training films, most of it likely to be impossible to replace, since the people who made those corporate videos likely have lost the masters, or they or their companies are no longer in existence.

The transmitter shed and outside broadcast van are still intact and it is hoped transmissions can recommence soon. Over the last quarter century the club has offered training courses for the Amateur Operators' Certificate of Proficiency and a great deal of hands-on experience in TV operations.

There are dozens of people working in technical and operational areas of the broadcasting industry whose skills were initiated and honed at TVG. In an industry where technical training has been systematically exterminated, TVG represents a resource that we cannot afford to lose.

Plans for a replacement house (and the studio) are being prepared and TVG supporters will soon be "passing the hat around" to TV stations for donations of unwanted standard definition equipment.

The Club fully intends to rise from the ashes, with the hope that they can build an all-digital facility. This will allow members and volunteers to experiment and work with technologies that more closely follow the latest industry practices. New and updated training courses can then be offered and new technical documentaries be produced to replace the lost library.

Further info is available at: **http://televisiongladesville.blogspot.com/ and http://tvg.org.au/**

Peter Collis and John Maizels, Neutral Bay, NSW. *SC*

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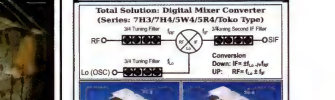

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556~599M	T7E6778D-580M~20M	2.5	T8F6439B-625M~30M	2.0
596~640M	T7E6779D-620M~22M	3.0	T8F6432E-666M~38M	2.5
661~700M	T7E6332E-666M~25M	2.5	T8F6417E2-670M~35M	3.0
701~750M	T7E6784B-725M~28M	3.0	T8F6648F-790M~35M	3.0
751~800M	T7E6784A-783M~25M	3.0	T8F6930A-815M~25M	3.5
801~830M	T7E6746A-813.5M~25M	3.0	T8F6450A-836.5M~25M	3.5
831~860M	T7E6721A-858.5M~20M	3.5	T8F6930A-815M~25M	3.5
861~900M	T7E6751F-881.5M~20M	3.0	T8F6930A-900M~30M	3.0
901~930M	T7E7550E-902.5M~27M	3.0	T8F6291A-915M~34M	4.0
931~959M	T7E7152A-940M~30M	2.5	T8F6265A-947M~40M	3.0
951~979M	T7E7266A-960M~34M	2.5	T8F6266A-960M~34M	4.0
976~1000M	T7E7267A-980M~35M	3.0	T8F6471A1-1015M~25M	4.0
1001~1100M	T7E7401A-1040M~32M	3.0	T8F6471A-1015M~25M	4.0
1101~1139M	T7E7556A-1150M~44M	3.0	T8F6538A-1170M~35M	5.0
1181~1250M	T7E7788B-1219M~35M	3.0	T8F6560D-1283.7M~29M	5.0
1251~1300M	T7E7789B-1272M~35M	3.0	T8F6426D-1280M~28M	5.0

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Biggest-WebShop-VHF UHF Standard BandPass Filter
Temwell Alternative Toko Type Filter online-72hr ship
Total 200Kpcs, 500 models, 2/3 tuning In-Stock

① 7HW/7HT Toko 302MXP Type UHF (2/3 Tuning Filter)

TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW
K2B1-360M-10M	K2B1-509M-13M	K3BT-435M-20M	K3CT1-853M-21M
K2B1-370M-10M	K2B1-529M-13M	K3BT-450M-20M	K3CT-859M-21M
K2B1-380M-10M	K3BT-370M-10M	K3BT-465M-15M	K3CT-865.5M-21M
K2B1-390M-10M	K3BT-370M-16M	K3B-485M-20M	K3BT-880M-25M
K2B1-410M-10M	K3BT-390M-10M	K3BT-510M-15M	K3CT1-904M-12M
K2B1-420M-10M	K3BT-390M-16M	K3BT-530M-15M	K3CT1-915M-12M
K2B1-435M-11M	K3BT-410M-11M	K3CT2-600M-20M	K3CT1-938M-19M
K2B1-452M-11M	K3BT-410M-16M	K3BT-612M-18M	K3CT1-947M-18M
K2B1-469M-11M	K3BT-410M-16M	K3CT2-651M-10M	K3CT1-969M-12M
K2B1-478M-11M	K3BT-415M-20M	K3BT-666M-13M	K3CT1-1019M-29M
K2B1-490M-13M	K3BT-425M-20M	K3CT1-833M-16M	

② 7HW Toko 252MXP Type UHF (2 Tuning Filter)

TW P/N-Fo-BW	Toko P/N	TW P/N-Fo-BW	Toko P/N
K2B-425M-20M	252MXP-2735A	K2B-453M-20M	252MXP-2765A
K2B-453M-20M	252MXP6-2737A	K2B-480M-20M	252MXP6-2765A

③ 5HW Toko type UHF Double Tuning Band Pass Filter

TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW
K2RB-360M-10M	K2RB-474M-11M	K2RB-617M-20M	K2RB-950M-25M
K2RB-380M-10M	K2RB-474M-11M	K2RB-700M-20M	K2RB-1018M-38M
K2RB-415M-10M	K2RB-509M-14M	K2RB-735M-20M	K2RB-1130M-38M
K2RB-425M-10M	K2RB-530M-14M	K2RB-822M-20M	K2RC-1199M-35M
K2RB-439M-10M	K2RB-545M-14M	K2RB-880M-20M	K2RC-1225M-35M
K2RB-450M-11M	K2RB-625M-14M	K2RB-914M-20M	K2RC-1305M-35M

④ 5HT Toko type UHF Triple Tuning Band Pass Filter

TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW
K3RT-360M-20M	K3RT-460M-18M	K3RBT-605M-18M	K3RBT-845M-20M
K3RT-380M-20M	K3RT-510M-28M	K3RBT-710M-28M	K3RBT-1018M-38M
K3RT-400M-15M	K3RT-495M-20M	K3RBT-735M-20M	K3RBT-1019M-20M
K3RT-410.7M-10M	K3RT-515M-20M	K3RBT-800M-20M	K3RBT-1058M-20M
K3RT-420M-15M	K3RT-518M-20M	K3RBT-830M-20M	K3RBT-1059M-20M
K3RT-435M-18M	K3RT-537M-14M	K3RBT-862M-20M	K3RCT-1129M-20M
K3RT-440M-18M	K3RT-500M-18M	K3RBT-890M-20M	K3RCT-1220M-20M

⑤ 7HW /7HT Temwell type VHF L38-220MHz (2&3 Tuning Filter)

TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW	TW-P/N-Fo-BW
T0671948-140M-9M	T0673228-220M-8M	T1671118-160M-10M	T1673638-240M-12M
T0672615-160M-8M	T0673482-240M-8M	T1671838-180M-12M	T1676848-260M-12M
T0673308-180M-9M	T0673378-260-10M	T1676118-200M-11M	
T0673285-200M-9M	T1676788-140M-13M	T1676118-220M-11M	

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Eye-Fi Wireless Digital Photography

Digital cameras and memory cards are fantastic – no more worrying about the cost of film, the cost of developing and printing . . . you can shoot to your heart's content. But then you have to "upload" all those photos to your computer. What if you didn't even have to do that – they just appeared on your PC all by themselves?

By ROSS TESTER

Touch wood, the Nikon digital cameras we use for all photography at SILICON CHIP haven't given us a moment's trouble.

But the memory cards have. We've gone through a few over the past few years, giving errors mainly due to physical damage.

That damage has occurred primarily when the card has been ejected from the camera and placed in the computer card reader (or vice versa). And taking lots of pictures means doing that quite a few times for each "shoot", checking the pics are what we want and so on.

I don't think I've been any more ham-fisted than the next person but a couple of cards have separated down their edges, another has simply ceased working (the computer knows it's there but it sits there like blancmange). OK, one was my fault – I dropped it and trod on it!

Fortunately, SD cards (and their variants, SDHC and MMC) are now ***much*** cheaper than they were even a couple of years ago. And they are ***much*** higher capacity as well.

But being able to store a couple of thousand shots on the card is relatively immaterial when all I want to do is dash off a couple of couple of dozen pics and transfer them to our server, so they can be processed.

I still have to take the card out of the camera, take it to my PC and insert it in the reader, wait for the computer to realise there is a "disk" there, find the appropriate folder and identify the photos I want, download the files, wait until it's all finished until I can remove the card . . . and then remember to replace it in the Nikon ready for next time.

I've lost count of the number of times I've walked around to our studio, set up lighting and so on, gone to take a picture and . . . the dratted memory card is still in the computer!

At least, that's what I used to do. . .

Now I simply take the photos. A short time later, the files automatically appear in a folder on the server, untouched by any human hands (or even animal hands).

Enter the World of ~~Wi-Fi~~ Eye-Fi

For a couple of years now, I've been trying to think of a simple way to avoid the problem of physically transferring cards. You might say that in the overall scheme of things, it's not one of the most world-shattering problems.

But it has been annoying enough to make me want to do *something*!

I'd thought about another (networked) PC in the studio and use a USB cable to the camera – but certainly couldn't justify that to the bean-counter-what-must-be-obeyed.

I'd thought about sourcing (or making?) an SD card reader with its own IP address which could simply hang off the network. Nah, still too expensive and/or too much like hard work.

I'd thought about a USB-to-Ethernet converter which could plug into the network. Ditto!

I'd thought about much more but in the end decided that I was destined to keep doing what I had been doing – sort of like the "sneakernet" we all used before networks were the vogue. (Haven't heard of a sneakernet? Where you took a floppy disk from one machine and walked around to another machine to share files etc? Oh, what's a floppy disk?)

Enough frivolity! Back to the subject at hand . . .

It must be at least 18 months or so ago that I read a press release from the US about the release of an "Eye-Fi" SD

All it takes is a compatible digital camera (and there are lots of those), an Eye-Fi card and a Wi-Fi network – and you're away!

Card. What set my heartbeat racing was that it was not only supposed to do exactly what I had been searching for, it would do it wirelessly, right from inside the camera.

Say again?

The release went on to say that an Eye-Fi card could connect any SDHC-compatible camera (and that's a huge number these days) to any Wi-Fi network and automatically transfer JPG or video files! But how? What *is* an Eye-Fi card?

Believe it or not, they said that along with the normal memory chips and drivers, a tiny Wi-Fi transceiver (802.11b-g) was built *inside* the SD card. So the files were sent direct from the camera, to wherever you wanted them to go, provided there was a Wi-Fi network within range.

Our network setup here at SILICON CHIP is probably not all that unusual and is relatively simple. It includes a permanently-on (albeit well hidden!) Wi-Fi access point so the Eye-Fi card should do exactly what we wanted.

But expand this idea a little, say to someone travelling overseas and taking lots of photos. Sure they could use lots of cards (and risk losing them or damaging them) – but wouldn't it be nice to be able to visit an internet café or wireless hotspot and send the pics home as soon as they were taken?

Or perhaps someone in the real estate, insurance, or countless other industries who needs to take pictures on the run, then send them on to clients, to the office, and so on.

Having found what appeared to be the perfect solution to my problem, the next step was obtaining an Eye-Fi card. First off, I had to wait until they were actually on sale (that was a few months) but then I set about buying one.

So I went through the most likely channel and contacted Eye-Fi direct. Their website has an online store. There was a range of Eye-Fi cards but I was only after the simplest one, the Connect X2, which was $US49.99 Bewdy!

Sorry. . . you can't have one!

But after I went right through the whole rigmarole of selecting and ordering, entering credit card details and so on, when I finally got to put the shipping address in . . . *"Sorry, we do not sell outside the US and Canada"*. Grrrr!

I emailed Eye-Fi and got exactly the same short shrift. Nope, we don't supply to Australia.

The Eye-Fi website also lists quite a number of "partners", so I thought it might be clever to go through them. Same story, *"not allowed to supply to your address"*.

Looking further afield, Amazon, which said they had Eye-Fi cards available, finally told me that *"licensing restrictions would not let them supply"* me.

OK, now it was getting to be a challenge. I thought "who do I know in the US or Canada?" but drew a blank there.

On a hunch, I had a look on good ol' eBay. Sure enough, there were several international suppliers offering Eye-Fi cards. The first one listed was one of those dealers I had tried off the Eye-Fi website. Scratch that one . . .

Hmm! Another on-line retailer in Florida, USA, (walhab.com) but not one of Eye-Fi's "dealers", was offering genuine, guaranteed Eye-Fi cards on a "buy it now" basis, actually a couple of dollars lower in price than from Eye-Fi or their own dealers (which were all identically priced).

So I put in my details, including Paypal . . . and presto: order confirmed, with 15-20 days delivery time.

Murphy's law determined that the day I ordered it exactly coincided with the Aussie dollar's 2010 nadir but even

with p&p, it came in under $AU60.

Since we bought ours, Eye-Fi cards are now sold in USA/Canada, England, France, Germany and Japan. But still not in Australia!

And another note: I searched walhab's website but couldn't find Eye-Fi cards listed – however, they are still selling them on eBay at time of writing (late August).

My Eye-Fi card arrives

It only took 12 days to arrive by post from the US and, being under $500, attracted no GST.

Included were the Eye-Fi card itself, a mini instruction manual, plus an SD-to-USB card reader/adaptor, for those who might not have any SD/MMC slots on their PC. In fact, the card itself was already inside the reader.

The instruction manual told me I needed 10 minutes(!), a PC running Windows XP/Vista/7 or Mac OS X 10.4 or higher, a Wi-Fi network (along with access codes and passwords), broadband internet access (to register the software) and finally a camera, so I could test my first shots.

By the way, apparently the Eye-Fi card can also be configured under Linux using eyefi-config, which allows viewing the logfiles and changing the wireless settings. To receive images from the card, there are two alternatives, Eyefi-server (in Python) and iiid (in C++). However, the UploadKey must still be defined from within Windows/Mac for the first use.

Plugging in the reader brings up the Eye-Fi folder, which in turn loads the Eye-Fi Helper software onto your PC. Once loaded, you're prompted to remove the Eye-Fi card from your PC and plug it into your camera, then take a test photo and, of course, leave the camera turned on.

Within a couple of minutes, a tiny Eye-Fi Helper window opens and you can see the files as they are transferred. With my picture files at about 4MB each, it takes the best part of a minute for each photo to upload but it does so in the background. As soon as a particular photo is uploaded, you can view and edit them with your normal photo software.

It's that simple! In my case, while the Eye-Fi Helper program runs on my PC, the files are actually stored on one of our network drives, a bulk photo repository if you like. The Eye-Fi Helper handled such changes with ease.

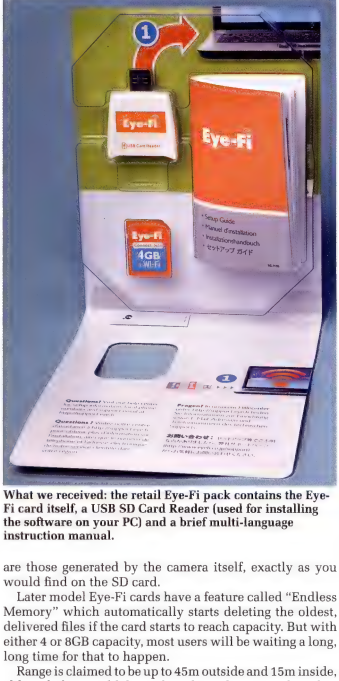
You can add up to 32 Wi-Fi networks to the Eye-Fi card setup – of course, you'll need any passwords and IDs just as you would for normal WiFi usage. I must admit I haven't tried the Eye-Fi card out with other Wi-Fi networks (hotspots, etc) because I am only concerned with our particular setup.

But the literature and reviews I've seen in recent months suggest there would be few problems there. Incidentally, earlier versions of Eye-Fi cards apparently couldn't work with hotspots but I believe the latest versions can.

How does it work?

Like normal SD cards, the Eye-Fi card relies on flash memory to store image files and in exactly the same manner. But at the same time, a wireless transceiver built into the same card (including the antenna) logs on to an available Wi-Fi network (one whose details have also been stored on the card) and starts transmitting the files via the Wi-Fi network to a previously specified PC and/or directory.

It automatically creates a sub-directory with "today" as its filename and saves the files to that. The photo filenames



What we received: the retail Eye-Fi pack contains the Eye-Fi card itself, a USB SD Card Reader (used for installing the software on your PC) and a brief multi-language instruction manual.

are those generated by the camera itself, exactly as you would find on the SD card.

Later model Eye-Fi cards have a feature called "Endless Memory" which automatically starts deleting the oldest, delivered files if the card starts to reach capacity. But with either 4 or 8GB capacity, most users will be waiting a long, long time for that to happen.

Range is claimed to be up to 45m outside and 15m inside, although this would depend to a large degree on obstacles, building construction, etc – just as with any Wi-Fi signal.

Of course, if the camera body was all metal, sealing the card inside, there would probably be no wireless range at all. Fortunately, the vast majority of today's cameras (even upmarket ones!) are based on plastic construction.

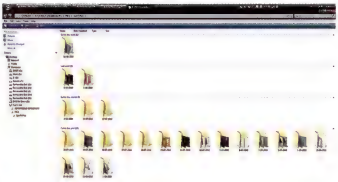
Inside the card

To look at, you'd never know the Eye-Fi card was any different from any other SD card. It's exactly the same size – 32mm long, 24mm wide and 2.1mm thick.

The card is manufactured for Eye-Fi by Wintec Industries Inc. in California and contains the following major components:

- Atheros AR6001GL "Radio-on-a-Chip for Mobile" (ROCm)
- Samsung Electronics K9LAG08-U1M NAND flash
- Hyperstone S4 flash memory controller

The Eye-Fi helper logo on the task bar (top of screen) flashes when an image is transferring, while the image itself, with progress bar, appears at the bottom of the screen.



The files automatically save into a directory (folder) with the label "today". This automatically changes to the appropriate date (in dd:mm:yy format) when today becomes tomorrow. Or is that yesterday?

- Epic Communications FM2422 compact RF front-end module
- Fairchild Semiconductor FAN5350 step-down switching voltage regulator

It's impressive to see how all this functionality has been packed into the card, especially when you consider that it still has the flash memory.

Incidentally, Eye-Fi was founded in 2005 by Yuval Koren, Ziv Gillat, Eugene Feinberg and Berend Ozceri. The last two gentlemen are believed to be the "brains" behind the Eye-Fi hardware.

In use?

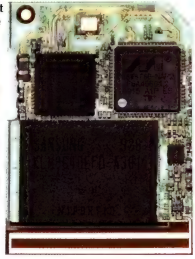
It's a dream! As I said at the outset, now I never have to remove the card from the Nikon (in fact, the first time I have had it out since new was to take the photos for this report!). It just happens . . .

Just a couple of caveats: you have to remember to leave the camera turned on until the last of the photos has been transferred – after years of ensuring I turned the camera off to preserve battery life, that's taken a bit of un-learning!

Second, and you might say bleedingly obvious, mate, is that both the computer and Wi-Fi network must be turned on to enable transfer. But not having them on doesn't mean you lose anything. Taking the photos of the boat on last month's cover was a case in point: it was about 20km away from the office but as soon as I returned, I turned the camera on and the photos started transferring immediately.

Incidentally, you can select the level of privacy you want, to tell the Eye-Fi card which pics you want it to transfer; for example, just in case you've taken some holiday snaps you might not want Great-Aunt Maude back in Australia to see.

Yes, I very much recommend the Eye-Fi card. Just a pity they make the thing so hard to buy! **SC**



Here's a rather significant enlargement of one of the latest Eye-Fi cards, the Pro-X2. The large chip (lower left of the pic) is Samsung flash memory, just as you would find in any other SD card, with its driver chip alongside. Top left is a Marvell wireless transceiver, which supports 802.11 b/g/n. Top right is an Eye-Fi chip that manages the chip's wireless networking and data transfer features. The 2.4GHz Wi-Fi antenna is integral within the card.

Current Eye-Fi Models

(Note: "theoretically" available only in North America, Europe and Japan. Unless you try hard!)

Eye-Fi Connect X2 With 4GB capacity, the Eye-Fi Connect X2 will automatically upload JPEG photos and videos to the computer and one of more than 25 online sharing sites, such as Flickr, Facebook, YouTube or Picasa, through a Wi-Fi network. **$US49.99.**

Eye-Fi Geo X2 – Similar to the Connect X2 but also offers lifetime, automatic Geotagging service to help you organise and share photos. View, search and share your latest trips on maps in iPhoto '09. **$US69.99**

Eye-Fi Explore X2 – With 8GB of flash memory, Explore X2 also offers one year of hotspot access for uploading away from home through open hotspots. **$US99.99.**

Eye-Fi Pro X2 – Unveiled at CES and winner of CNET's "Best of CES" award, the 8GB Eye-Fi Pro X2 allows users to create an ad hoc connection directly to their computer to wirelessly upload photos and videos while away from a wireless router. Like Explore X2, Pro X2 offers lifetime geotagging and one-year of hotspot access to enable uploads away from home. **$US149.99**

More info? www.eye.fi – *just don't try to buy one from them!*

JOTA/JOTI 2010:

"The right to be heard"

On October 16 and 17, up to half a million Scouts and Girl Guides from around the world will join together by radio and the internet in what has become known as JOTA – the Jamboree on the Air – and now JOTI, the Jamboree on the Internet.

In Scouting parlance, the word "Jamboree", first coined by Lord Baden Powell, means a large gathering of Scouts, engaged in a range of activities which can be as diverse as pottery to caving to abseiling to . . . amateur radio!

JOTA/JOTI brings together, electronically, up to half a million Scouts (and of course Girl Guides) from theoretically just about every country on the planet.

The 2010 event is of special significance – it's the 100th anniversary of the Guiding movement (the Scouts had their centenary back in 2007) and at the same time, the 20th anniversary of the International Convention of the Rights of the Child. In fact, this year's theme, "The Right to Be Heard" is directly related to article 12 of that Convention.

The International Amateur Radio Union (IARU) is fully supporting the Scouts to participate in JOTA. And even further, IARU encourages members to educate them in radio techniques so that they may operate their own station.

The IARU Region 1 Conference 2008 in Cavtat, Croatia passed the following resolution CT08_C3_Rec 24: (Paper CT08_C3_39): *In recognizing the importance of the JOTA (Jamboree-On-the-Air) for radio amateur recruiting, it is recommended that Member Societies encourage radio amateurs to assist boy Scouts and girl Guides to participate in the annual JOTA the third full weekend of October each year, organized by the World Organization of the Scout Movement (WOSM) and to use this opportunity to present amateur radio recruiting possibilities to the Scouts/Guides.*

The Wireless Institute of Australia, the peak body representing amateur radio operators in Australia (and a member of the IARU) supports and encourages its members to in turn support JOTA.

by ROSS TESTER

Under the watchful eyes of Scout and Girl Guide leaders, campers put together a project – in this case, an Electronic Dice from Jaycar's "Short Circuits II" book. The majority managed a working project at the end of the session – not too bad considering that many of the youngsters had never touched a soldering iron before JOTA! (This was the 2009 camp). Photo opposite: Flynn Jagoe VK6FFFF, from Perth, searches for contacts on the JOTA amateur radio network.

Participation in JOTA can be as simple as Scouts and Girl Guides asking a local amateur operator to come to the local scout or guide hall and set up a "portable" station, supervising Scouts and Girl Guides while they use the equipment in an attempt to contact their peers. Other amateurs really get behind their local Scout and Guides and set up radio equipment on a much larger scale.

Depending on the equipment being used, contacts may range from someone in a nearby suburb or town, right through to someone on the other side of the globe.

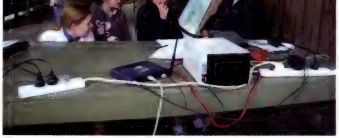
The World Scouting organization has recommended frequencies, covering a range of bands, for JOTA participants to use. All they have to do is get on air and call "CQ Jamboree" and anxiously wait for another Scout or Girl Guide to answer the call. (See overleaf)

It's not a contest. There are no prizes for the most contacts, although that is one of the aims of the Jamboree of the Air. All stations do, of course, have to be operated strictly in accordance with their country's amateur radio licencing regulations (invariably, that includes having a licenced amateur in attendance at all times).

JOTA history

JOTA was conceived by an English amateur operator,

. . . "like ducks to water": the internet tent was very popular – most kids these days have an excellent grasp of technology (much moreso than their parents!).



The Manly-Warringah Radio Society provided the equipment and the licenced amateurs to supervise – here with Abbey, Tia and Emma from 1st Elanora Girl Guides.

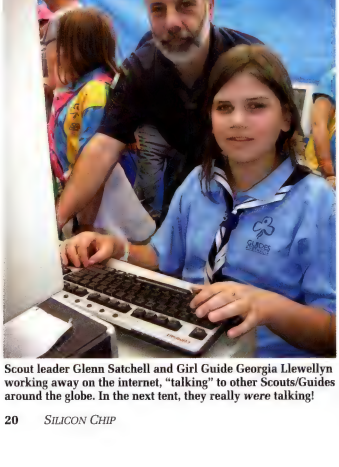
World Scouting JOTA Frequencies

Several amateur radio bands have designated frequencies where Scout stations can meet. Of course, the whole authorised band can be used for Scout contacts, however, to easily find Scout stations, particularly during JOTA, listen in on the following Scout frequencies:

Band	SSB (phone)	CW (morse)
80 m	3.690 & 3.940MHz	3.570 MHz
40 m	7.090 & 7.190MHz	7.030 MHz
20 m	14.290MHz	14.060 MHz
17 m	18.140MHz	18.080 MHz
15 m	21.360MHz	21.140 MHz
12 m	24.960MHz	24.910 MHz
10 m	28.390MHz	28.180 MHz
6 m	50.160MHz	50.160 MHz

Les Mitchell, G3BHK, to coincide with the 50th anniversary of Scouting in 1957. It is now considered the largest event scheduled by the World Organisation of Scouting Movements.

In 2000, Les Mitchell wrote *"Little did I think when I drew up the plans and rules for the first event in 1958 that its popularity would increase and spread around the world. Even more astonishing is the fact that after all this time it still holds its popularity and now has a participation of some half a million Scouts and Guides in over one hundred countries involving some ten thousand amateur radio stations. In fact it has become the largest international Scout event ever."*



Scout leader Glenn Satchell and Girl Guide Georgia Llewellyn working away on the internet, "talking" to other Scouts/Guides around the globe. In the next tent, they really *were* talking!

As each contact was made, they had to work out where the person was. JOTA/JOTI goes over 48 hours so there was always someone awake somewhere on the planet.

Enter the internet

The Jamboree on the internet, JOTI, was conceived a lot more recently, 1995, here in Australia.

A Queanbeyan Rover, Norvan Vogt was on a student exchange in the Netherlands. Back in Australia a home team co-ordinated by Brett Sheffield connected Putten, Netherlands and Queanbeyan, Australia with dedicated IRC (Internet Relay Chat) servers.

In November 1996 the World Scout Committee, noting that Scouting already had a considerable presence on the Internet and that there was already an informal and rapidly growing Jamboree on the Internet, decided that JOTI should become an official international Scouting event, and that it should be held on the same weekend as the Jamboree on the Air (JOTA). Today, the internet has become as much a part of JOTA as amateur radio equipment.

Much more than talking!

While many Scouting groups simply use JOTA/JOTI as a means of communicating around the world, many more use the JOTA/JOTI weekend as the opportunity for a Scouting Jamboree in its own right, with JOTA/JOTI activities forming but one part.

Electronics and radio badges are sought-after by Scouts and Girl Guides, with many leaders themselves trained in electronics and radio – indeed, many leaders are also licenced amateur radio operators.

They introduce the young Scouts and Girl Guides to electronics and often have them building their own projects as an aid to understanding. Many scouting groups offer training for older scouts and Guides to become licenced amateurs in their own right, thereby passing on their knowledge to the next generation.

JOTA/JOTI on the Northern Beaches

Here in Sydney, each year as part of the JOTA/JOTI weekend the Sydney Northern Region Scouts and Girl Guides gather for a jamboree on the banks of Narrabeen Lagoon.

They are assisted by members of the Manly Warringah Radio Society who provide both equipment and licenced operators which allow a constant stream of contacts around the world.

The 2009 camp, some of which is shown in the accompanying photos, was no exception. With the assistance of a new HF dipole antenna, the Narrabeen JOTA logged 45

What's a Scout/Girl Guide Jamboree without a bit of canoeing, rope climbing, volleyball, boomerang throwing, and . . . food! And a campfire on the JOTA weekend really capped it off.

QSOs (contacts): 6 local, 25 interstate and 14 international.

On the JOTI side, a network of 15 computers provided Internet Relay Chat using the Scoutlink network. As contacts were made the scouts identified the city and country and put stickers on their world map.

Highlights were contacts on the Faroe Islands, Tenerife in the Canary Islands, and a lone scout on the Namibia/Angola border in Africa.

In addition, most of those attending received instruction in electronics and soldering, then attempted to build an Electronic Dice (from Jaycar's Short Circuits). Some found it a bit challenging: at the end of the session about 70% were rewarded with a working project, while the rest completed the task at a later event.

The North Harbour Water Activities team took the Scouts and Girl Guides canoeing on Narrabeen Lagoon and along Middle Creek. In the spare time there was a water slide, swimming in the lake, boomerang throwing and a clever radio wide game. A movie and campfire on Saturday night topped off the weekend.

(The JOTA camp website http://jota.uniq.com.au has lots of JOTA and JOTI-related information).

Incidentally, we understand that as part of the 2010 JOTA/JOTI, one of the aims is to teach Morse Code – via the vuvuzela (might be a good reason not to travel to Narrabeen on the third weekend in October?).

SC

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dick smith
Talk to the Techxperts

A high-quality DAB+ tuner to build

We know you've been waiting for it and after more than a year in development, we are delighted to present this world-first high performance DAB+/FM stereo tuner design. It has all the bells and whistles of DAB+ in a sleek pro-quality case, with all features accessible by remote control.

THERE ARE LOTS of DAB+ radios out there but most are little mantel-style sets with limited features and tinny sound – far below the performance that DAB+ is capable of. Make no mistake – this SILICON CHIP design will extract the very best sound quality possible out of every DAB+ broadcast signal, regardless of the sampling rate used. As well, it is also a very fine FM stereo tuner so you can listen to the FM versions of the programs – and often get even better signal quality from the analog broadcast.

Our design is based on the renowned Venice 7 DAB+/FM radio module from leading developer Frontier Silicon Co in the UK. This module is widely used in many, if not most, DAB+ radios but as we should reiterate, those designs don't do justice to it.

By the way, the Venice 7 module is fully assembled so you don't have to worry about soldering tiny state-of-the-art surface-mount chips – you just clip it into the main circuit board. This is driven by a dsPIC33FJ256GP506 microcontroller from Microchip Inc and this provides all the fancy display features.

Housed in a handsome case, the DAB+/FM Tuner will match in well with other hifi equipment. The front panel controls have been kept to a minimum, since all the features can be accessed using an infrared remote control. A blue ACKnowledge LED flashes to indicate when remote control signals are being received.

The main highlight is the large backlit LCD panel which displays white text and graphics on a blue background. The display resolution is 160 x 80 pixels.

This LCD shows all the station information from DAB+ stations and also from the FM stations when RDS (Radio Data Service) is being used.

By MAURO GRASSI

Features & Specifications

FEATURES

- FM/DAB/DAB+ Radio (VHF Band 2 & 3, UHF L-Band)
- FM RDS (Radio Data Service) and DAB+ DLS (Dynamic Label Segment) display to show text information
- 10 FM station presets
- 10 DAB/DAB+ station presets
- Time and date display
- Infrared remote control
- 160 x 80 pixel graphics white-on-blue backlit LCD
- RCA stereo output and S/PDIF TOSLINK digital output
- Can play WAV files from an MMC/SD/SDHC memory card

SPECIFICATIONS

THD+N: 0.09% mono, 0.13% stereo

Signal-To-Noise Ratio (SNR): 71dB mono, 60dB stereo

30dB Quieting: 23dBf/4μV mono & stereo

50dB Quieting: 31dBf/10μV mono; 41dBf/30μV stereo

As well, the SILICON CHIP DAB+/FM Tuner will allow you to play your favourite music via WAV files stored on a memory card. Just plug it into the front panel slot. So if you don't like what is on offer from the radio channels at the moment, you can play your own selection.

There are six front-panel buttons for station presets and two more for mode and menu selection. Apart from the power switch on the lefthand side and the blue ACKnowledge LED, there is no other clutter on the front panel except for a rotary encoder. This is controlled by a large knob and is used to select stations and menu features.

Numerous features, to be described later, are available via the infrared control. For example, there are 10 DAB+ station presets and 10 FM station presets and heaps of menu features which you can set or leave as defaults.

The rear panel carries sockets for the antenna input and analog stereo outputs (RCA phono). In addition, there's a TOSLINK (optical) digital output, a power socket and a DB9 serial socket to allow the firmware to be updated, if required. Power comes from an external 9V AC 500mA plugpack, so there's no mains wiring to worry about.

All the circuitry is carried on two PC boards: a main board and a front-panel display board. The main board carries the Venice 7 DAB+/FM module, the dsPIC33FJ256GP506 microcontroller, the analog output circuitry, the TOSLINK transmitter and the power supply components, while the display board carries the LCD, the pushbutton switches and the rotary encoder.

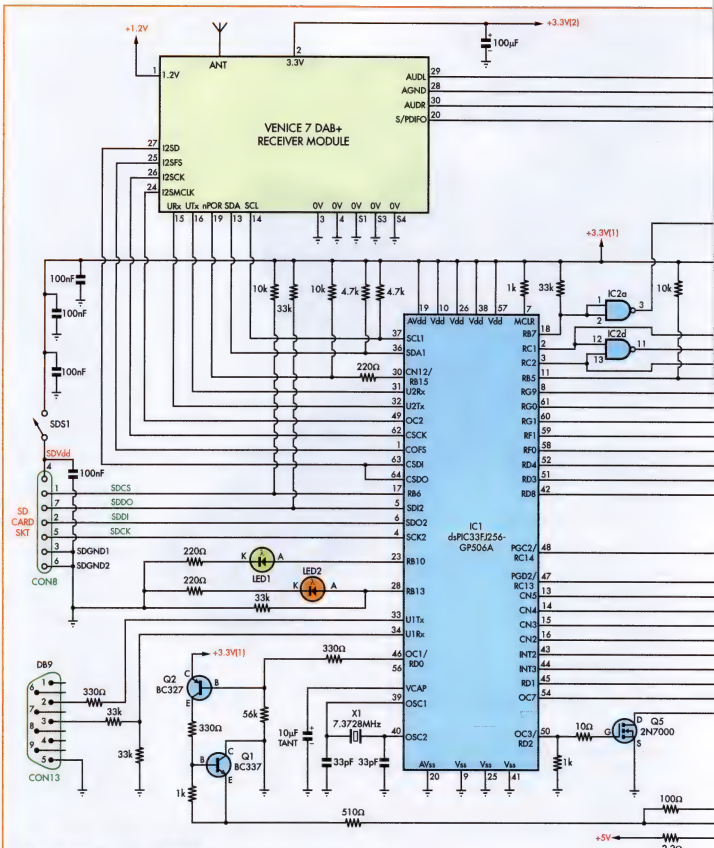
As shown in the photos, the main board mounts in the bottom of the chassis while the display board sits vertically behind the front panel. The two boards are linked together via a multi-way ribbon cable.

Circuit description

Refer now to Fig.1 for the main board circuit. It can be split into five parts: the Venice 7 DAB+/FM module, the dsPIC33FJ256GP506 microcontroller, a TOSLINK transmitter, a stereo analog output stage and a power supply section.

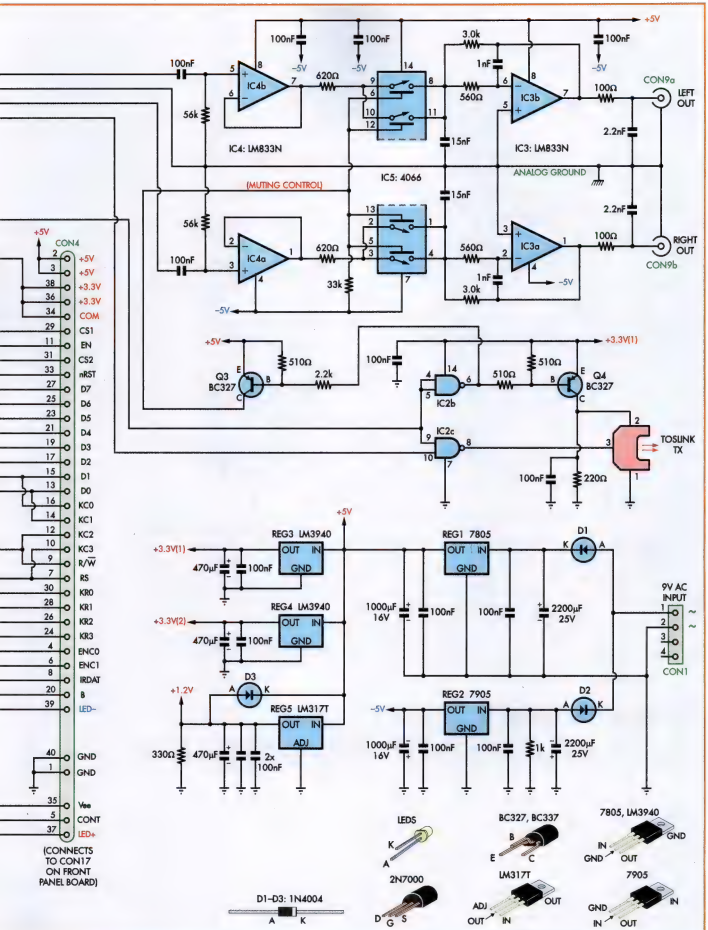
The Venice 7 module from Frontier Silicon contains all the RF and digital circuitry necessary to decode DAB+ and FM stereo multiplex signals. It produces an S/PDIF digital audio signal stream and stereo audio signal outputs when it is tuned to a station. An input is provided for a 75Ω antenna cable and the unit is connected to the main PC board via two pin headers, one 30-way and the other 14-way.

The Venice 7 receiver module is manufactured in two versions, either as a slave or master module. Our design uses the slave version and this is controlled by commands from



DAB+/FM TUNER MAIN BOARD CIRCUIT

Fig.1 the main board circuit can be split into five parts: the Venice 7 DAB+/FM receiver module, a dsPIC33FJ256GP506 microcontroller (IC1), a TOSLINK transmitter, a stereo analog output circuit (IC3, IC4 & IC5) and a power supply based on 3-terminal regulators REG1-REG5. Power comes from an external 9VAC plugpack supply.


+5V
100nF
IC4b
620Ω
56k
IC4: LM833N
3.0k
1nF
560Ω
IC3b
100Ω
CON9a
LEFT OUT
2.2nF
15nF
IC3: LM833N
IC5: 4066
(MUTING CONTROL)
ANALOG GROUND
IC4a
33k
IC3a
RIGHT OUT
CON9b
-5V
CON4
+3.3V
COM
CS1
EN
CS2
nRST
D7
D6
D5
D4
D3
D2
D1
D0
KC0
KC1
KC2
KC3
R/W
RS
KR0
KR1
KR2
KR3
ENC0
ENC1
IRDAT
B
LED-
GND
Vee
CONT
LED+
(CONNECTS TO CON17 ON FRONT PANEL BOARD)
Q3 BC327
510Ω
2.2k
IC2b
IC2c
Q4 BC327
+3.3V(1)
TOSLINK TX
220Ω
REG3 LM3940
REG4 LM3940
REG5 LM317T
REG1 7805
REG2 7905
OUT
IN
GND
ADJ
470µF
1000µF 16V
2200µF 25V
D1
D2
D3
9V AC INPUT
CON1
+3.3V(2)
+1.2V
330Ω
2x 100nF
1k
LEDS
BC327, BC337
7805, LM3940
2N7000
LM317T
7905
D1–D3: 1N4004

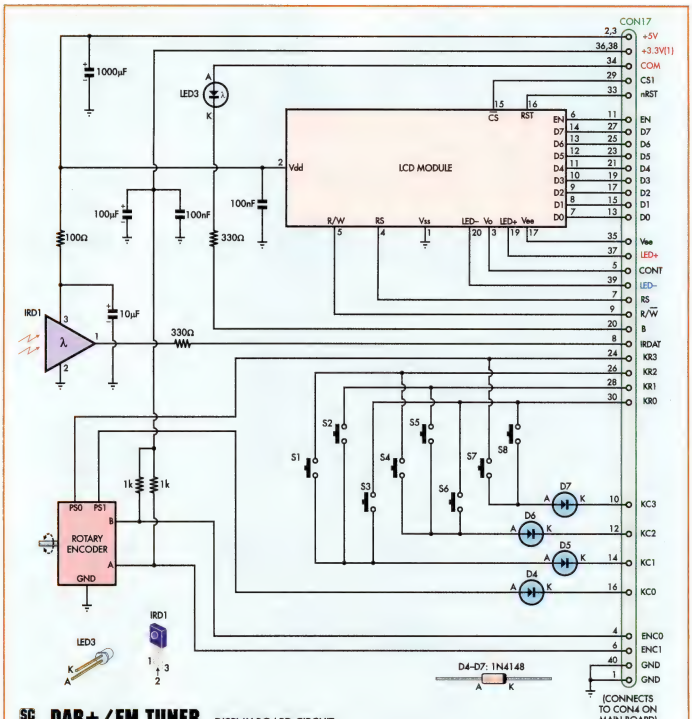


Fig.2: the display board circuit uses a backlit LCD module which has a resolution of 160 x 80 pixels. This board also carries an infrared receiver (IRD1), a rotary encoder and eight pushbutton switches for the station presets and menus.

the dsPIC33FJ256GP506 micro (IC1) via the serial port. This serial port consists of two lines at pins 15 & 16 of the receiver module (URx & UTx) and these are driven via pins 31 & 32 of the dsPIC microcontroller.

The serial port runs at 115,200 bps and uses an 8-bit word with one stop bit and no parity. The microcontroller sends commands to the Venice 7 module and receives data back from it. Error detection is accomplished using a checksum appended to each packet sent.

The Venice 7 receiver module is also connected to the microcontroller's I^2C peripheral, ie, the SDA & SCL signals at pins 36 & 37 respectively. This is a low-speed serial bus requiring only two lines that can be used to communicate with many different devices. The two lines are pulled up by two 4.7kΩ resistors. However, while this connection is there, it is not currently used by the firmware.

The receiver module is reset by bringing the nPOR line (pin 19) low. This line is driven by the microcontroller using a digital I/O pin configured as an output (RB15 at pin 30)

via a 220Ω resistor. Note that the line is normally pulled high via a 10kΩ resistor to the +3.3V rail, so that the receiver module is not also reset when the microcontroller is reset.

The 220Ω resistor is used for current limiting. The Venice 7 module also pulls its nPOR pin low on start-up and although the firmware is designed to cater for this, this resistor protects both pins in case the module unexpectedly resets (asynchronously to the microcontroller).

I²S interface

Another four lines are used to access the I²S (Inter-IC Sound) interface of the Venice 7 module. These are MCLK (Master Clock, pin 24), SCLK (Shift Clock, pin 26), FS (Frame Sync, pin 25) and D (Data, pin 27).

When the Venice 7 module is decoding audio from a radio signal, whether it is digital or FM, these lines carry digital, uncompressed, stereo audio data. On the other hand, when the DAB+ Tuner is playing an uncompressed WAV file from the memory card, the lines carry data in the opposite direction, from the dsPIC microcontroller to the Venice 7 module.

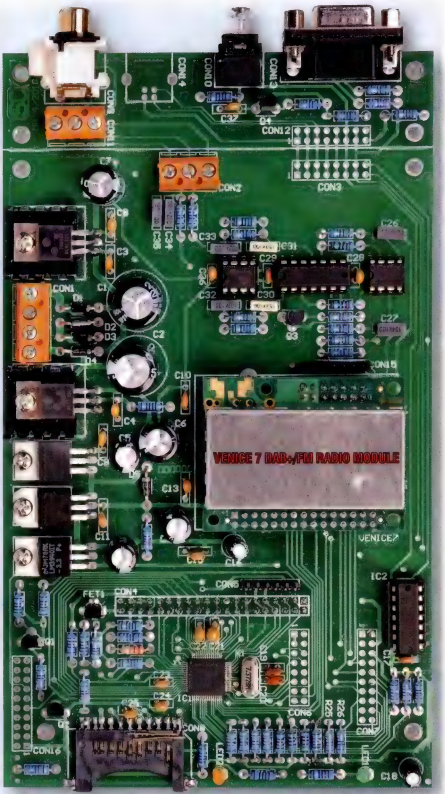
In a typical I²S application, the MCLK line is the oversampling clock signal and this can be used to drive an external DAC. There are good reasons to use an oversampling clock when it comes to audio quality and cost but we won't go into all these here. Suffice to say that the main reason for using it is that it allows the use of simpler (and cheaper) audio filters on the output of the DAC. These achieve the same effect as a more expensive multi-pole filter which would be required if oversampling was not used.

In this design, the MCLK master clock line is connected to an "Output Compare" pin on IC1 (ie, OC2 at pin 49). The "Output Compare" peripheral on the dsPIC microcontrollers (and other Microchip microcontrollers) is most commonly used to generate a PWM (pulse width modulated) signal but it can also be configured in other modes. Here it is used to generate a square wave from the internal system clock of IC1. This serves as the master clock when the microcontroller is sending data to the Venice 7 module.

Alternatively, when the Venice 7 module is decoding audio, it acts as a general I/O pin and is configured as a digital input. In this case, the audio data is read by the microcontroller and is processed by the firmware to display both the audio level and the frequency spectrum.

It also allows the microcontroller to detect silence and static on FM stations and this is processed by the firmware to control the muting. In operation, the microcontroller will mute an FM station if it detects only static.

The reading of the digital audio data occurs almost transparently in



This view shows the main board assembly, with the Venice 7 DAB+/FM radio module mounted in position. The assembly details are in Pt.2 next month.

The rear panel provides access to the serial port, TOSLINK transmitter and the analog stereo outputs (RCA sockets). It also carries the antenna and power sockets. A standard 40-way IDE cable is used to connect the two PC boards.

the dsPIC, using DMA (Direct Memory Access) and its DCI (Data Converter Interface) peripheral. The latter can be used to interface to a number of audio coders and decoders. In particular, it can code and decode an I^2S stream.

The bit clock (I^2SCK, pin 26) allows the serial audio data to be decoded and is connected to the CLK signal of the DCI peripheral of IC1 (CSCK at pin 62). The data signal (I^2SD, pin 27 of the Venice 7 module) is connected to both the CSDI (Data In) and CSDO (Data Out) lines of the DCI peripheral of IC1 (at pins 63 & 64 respectively).

The other signal used is the frame sync (I^2SFS, pin 25), which for I^2S goes high or low depending on whether data is being transmitted for the left or right audio channel. Its frequency is equal to the sampling frequency of the digital audio stream. This is connected to the DCI peripheral's COFS pin (pin 1 of IC1).

TOSLINK output

The two audio outputs of the Venice 7 module (pins 29 & 30) are fed to the analog output stage, while the S/PDIF output (pin 20) is fed to the pin 10 input of NAND gate IC2c. This gate allows the digital stream to be muted via one of the microcontroller's digital I/O pins (ie, RB7, pin 18).

When the unit is muted, RB7 is high and the output of NAND gate IC2a (configured as an inverter) is low. This in turn means that pin 9 of IC2c is low (and so no data can pass through IC2c), while IC2b's output is high. The latter is used as a simple buffer to drive the base of PNP transistor Q4. So Q4 is off whenever RB7 is high and on otherwise.

This transistor simply switches power to the TOSLINK transmitter (+3.3V). As a result, when the mute is active, no power is applied to the TOSLINK transmitter (and no data passes through IC2c). The 220Ω resistor is there to provide a minimum load for Q4's collector, while the 100nF capacitor bypasses the TOSLINK transmitter's supply rail.

Note that the TOSLINK output only operates for radio mode (ie, when using DAB/DAB+ or FM mode). It does not output any data when playing back WAV files from the memory card. This is because it is the microcontroller that controls the WAV playback and no S/PDIF signal is generated. You will have to use the stereo audio outputs if you want to use both radio and WAV playback modes, while using just one amplifier input.

dsPIC microcontroller

The dsPIC33FJ256GP506(A)-I/PT microcontroller (IC1) comes in a surface-mount TQFP-64 (64 pin) package. **This will be supplied programmed and soldered in position on the main PC board if the DAB+/FM Tuner is purchased as a kit.**

This microcontroller has 256KB of program memory and 16KB of SRAM. It can run at up to 40 MIPS (million instructions per second) and in this application it runs at 39.6288 MIPS. This frequency is derived from a 7.3728MHz crystal (X1) using the on-board primary oscillator. The two 33pF ceramic capacitors provide the correct loading for the crystal.

In operation, the system frequency of 39.6288MHz is derived using internal divide and multiplication (PLL – phase locked loop) stages as follows:

$$[172(7.3728 \times 10^6)]/32 = 39.6288 \times 10^6$$

The reason for using this frequency is that it allows the two most common audio sampling frequencies (44.1kHz and 48kHz) to be closely approximated for WAV playback, while also being very close to the maximum operating frequency (to allow the microcontroller to run as fast as possible). Both sampling frequencies can be approximated to within ±0.8%.

It is also a good frequency for serial port communication with the Venice 7 module.

IC1 is powered from one of two

+3.3V supply rails and this has a number of 100nF monolithic decoupling capacitors. The core runs from 2.5V and this is derived using an internal low drop-out regulator. This regulator requires a 10µF decoupling capacitor to GND at the VCAP output (pin 56).

Finally, the IC1's reset line (MCLR-bar at pin 7) is pulled high by a 1kΩ resistor to enable the power-on reset logic to function.

Memory card

The DAB+/FM Tuner has a slot on the front panel that allows an MMC/SD/SDHC memory card to be inserted into connector CON8.

Basically, the memory card can be used to store music in uncompressed WAV format. This type of file is essentially a channel-interleaved file of PCM (Pulse Code Modulation) audio sample data. This means that (usually) a 16-bit sample for the left channel is followed by a 16-bit sample for the right channel.

The sampling frequency determines the number of 16-bit sampling pairs per second, eg, a 44.1kHz sampling rate gives 44,100 sample pairs per second. For mono WAV files, there are half as many samples.

The memory card also adds a few other functions, such as saving the tuner settings (eg, station presets). We'll talk about these functions when we explain how to operate the DAB+/FM Tuner in a future article.

Note that it's necessary to insert the memory card when the power is off, as the memory card detection occurs on start up.

MMC/SD/SDHC cards can be accessed either in their native mode or in SPI mode. The advantage of SPI mode is that the interface is simpler and so this is the mode used in this circuit. The penalty is slower transfer speeds. However, SPI speeds are quite adequate for playing back uncompressed stereo WAV files at sampling rates up to 48kHz.

The microcontroller communicates with the memory card over one of the SPI (Serial Peripheral Interface) buses (SPI2). SPI1 is reserved for possible future use and is not currently used.

SPI communication requires four lines: SDCS (chip select – active low), SDDO (serial data output), SDDI (serial data input) and SDCK (serial clock). In this case, the microcontroller is the SPI master and controls the SDCS line. When it is pulled low, the memory card becomes active and listens for commands. The SDDO and SDDI lines are used to transmit and receive data in conjunction with the clock line (SDCK) which is generated by the microcontroller.

The SDCS line is pulled high by a 10kΩ resistor, while the data output line from the memory card is pulled high by a 33kΩ resistor. The memory card socket (CON8) also contains two switches, one of which is NO (normally open) but closes when a memory card is inserted into the socket. This is used to switch power to the memory card, ie, from the +3.3V rail to pin 4 of CON8.

In addition, there are two ground connections at pins 3 & 6 of CON8. The four remaining SPI lines are connected to the microcontroller. Note that the data lines are connected transposed to allow full duplex communication.

The SPI bus runs at close to 10MHz, which is about the fastest that the microcontroller will allow.

Serial port

The microcontroller has two serial ports. UART2 (at pins 31 & 32) is used to communicate with the Venice 7 module (to send commands and receive data), while UART1 (pins 33 & 34) connects to the external DB9 socket (CON13). This allows the unit to be connected to a PC, either directly to a native RS232 port or indirectly via a serial-to-USB cable.

The main reason for connecting to a PC is to allow the microcontroller's firmware to be updated, in the case that future upgrades are made available. This can be done using a bootloader application for Windows operating systems (more on this in Pt.3).

The serial port can also be used to help diagnose any problems with the radio module in "bridge mode". In this mode, external data received via the serial port is passed directly to the Venice 7 module and similarly, data received from the Venice 7 module is fed to the serial port. The microcontroller simply acts as a relay, allowing the Venice 7 module to be controlled directly from a PC.

We won't be describing how this is done however, since it won't be necessary for kit constructors to do this.

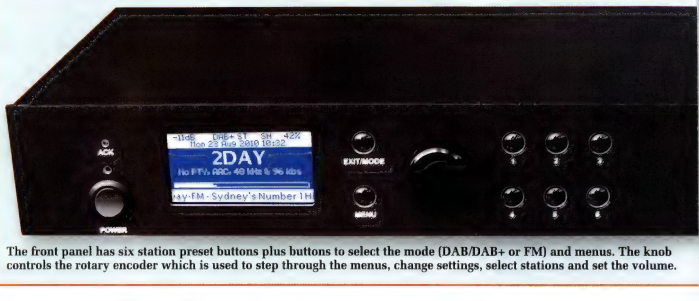
Only three lines are connected to the DB9 socket: the transmit and receive lines plus the ground connection. As shown, the transmit line at pin 33 (U1TX) is connected via a 330Ω current limiting resistor to pin 2 of CON13 (which is the Rx receive line). By contrast, the receive line at pin 34 (U1RX) is connected via a voltage divider formed from two 33kΩ resistors to pin 3 of CON13 (which is the Tx transmit line).

The voltage divider is necessary to step down the voltage on the Tx line to a 5V level before it is fed to pin 34 (a 5V tolerant pin) of the microcontroller (IC1).

Analog output circuitry

The stereo analog outputs (AUDL & AUDR) of the Venice 7 module appear at pins 29 & 30. The analog ground at pin 28 (AGND) is connected to system ground inside the module but for best audio quality, it should carry only audio return current. The PC board has been designed to carry all the audio return current to this pin.

The two audio channels are identical, so we will only describe the operation of the left channel. As shown, the left output (AUDL) is AC-coupled into non-inverting buffer stage IC4b (one half of an LM833N low-noise dual op amp). This buffer and the high-pass filter formed by the 220nF capacitor and the 56kΩ resistor present a minimal



The front panel has six station preset buttons plus buttons to select the mode (DAB/DAB+ or FM) and menus. The knob controls the rotary encoder which is used to step through the menus, change settings, select stations and set the volume.

load on the high-impedance output of the radio module.

IC4b's output is in turn fed to analog switch IC5 (4066) via a 620Ω resistor. IC5 contains four switches and two are used in parallel for each audio channel, to lower the switching resistance (ie, the R_{DS}(on) of the Mosfets in IC5) and hence the distortion.

The paralleled switch output appears at pins 8 & 11 and is fed to op amp IC3b via a multiple feedback filter network (620Ω, 3kΩ, 560Ω, 15nF & 1nF). The low resistance values in this filter ensure that we are dealing with signal currents (rather than signal voltages) through the analog switches, to take advantage of their improved linearity in this mode.

IC3b functions as a second order low-pass filter with a cutoff frequency of around 31.7kHz and a gain of around -4.8 to provide line level output signals. The 100Ω resistor and 2.2nF capacitor provide further low-pass filtering at its output.

This audio filtering is necessary to remove any switching artefacts generated by the DAC (Digital-to-Analog Converter) inside the Venice 7 module.

Analog output muting

The analog audio outputs are muted by turning the analog switches off. This is done using transistor Q3 which drives a common muting control line for all four switches inside IC5.

Q3 is controlled by the RB7 (pin 18) output of IC1 via NAND gate inverters IC2a & IC2b. As described previously, this also controls the muting for the TOSLINK transmitter.

As shown, pin 6 of IC2b drives Q3's base via a 2.2kΩ resistor. IC2b operates from a 3.3V rail and the divider formed by the 2.2kΩ and 510Ω resistors on Q3's base provides level translation.

When IC2b's output switches high to +3.3V (ie, when RB7 of IC1 is high), Q3's base will be at about 4.7V and so Q3 will be off. Conversely, when IC2b's output goes low, Q3's base voltage drops to about 4.1V and Q3 turns on.

When Q3 is on, the muting control line is pulled high and this closes the analog switches in IC5. As a result, the stereo audio signals are fed through to op amps IC3b and IC3a and finally to the stereo RCA output sockets. Conversely, when Q3 is off, the 33kΩ pull-down resistor on its collector will keep the switches off and the analog outputs are muted (as is the TOSLINK output).

Power supply

Power for the circuit is derived from a 9V AC 500mA plugpack supply. Its output is fed in via CON1 and applied to two half-wave rectifiers (D1 & D2) to derive ±12V unregulated rails.

The advantage of using an AC plugpack is that there is no need for internal mains wiring, which greatly simplifies the construction of the DAB+/FM Tuner.

The unregulated ±12V rails from the rectifier are filtered using 2200μF capacitors. They are then fed to positive and negative 3-terminal regulators REG1 & REG2 to derive ±5V DC rails. These rails are in turn filtered using 1000μF capacitors, while the 100nF capacitors on the inputs and outputs of the regulators shunt any high-frequency noise.

Note that the 2200μF filter capacitor on the -12V rail has a 1kΩ resistor connected across it to ground. This is included because this rail would otherwise have less loading than the +12V rail and it ensures that the two 2200μF capacitors discharge at about the same rate after switch off.

The ±5V rails are used to power the op amps (IC3 & IC4), while the +5V rail is also used to power the LCD and the infrared receiver (IRD1) on the front panel board.

While ±5V rails may seem to be on the low side for powering the LM833N op amps, our tests show that the distortion produced by these devices is still low enough to make it irrelevant in this application. That's because the distortion of the signal from the radio module is higher than in the analog output stage.

The advantage of using 5V rails is that both the LCD module and infrared receiver (IRD1) run off 5V, so there's no need for an additional regulator.

REG1's output is also fed to 3-terminal regulators REG3, REG4 & REG5. REG3 & REG4 are both LM3940 low-dropout types and are used to derive regulated +3.3V rails. REG5, on the other hand, is an LM317T adjustable regulator and is used here to derive a +1.2V rail (more on this shortly). All outputs are filtered using 470μF and 100nF capacitors.

The Venice 7 module is powered using two of these voltage rails – the +3.3V rail derived from REG4 and the +1.2V rail from REG5. The +3.3V rail

is used to power the module's RF front end and its audio output circuitry, while the +1.2V rail is used for the digital processing circuits.

The microcontroller is powered from the separate +3.3V rail derived from REG3. This prevents any digital switching noise generated by the microcontroller from being injected into the supply rail to the Venice 7 module, as this could degrade the audio quality.

As indicated above, the +1.2V (nominal) rail is derived using adjustable regulator REG5. This device maintains a voltage of 1.25V between its OUT and ADJ pins, although in practice this can be anywhere between 1.2V and 1.3V (due to manufacturing tolerances). The Venice 7 module can tolerate an error of ±10% for its 1.2V rail, so this is within specification.

Diode D3 is there to protect REG5 if the voltage on its output exceeds its input (eg, if there is a fault elsewhere in the circuit). The 330Ω resistor to ground provides a minimumal load for REG5 if the Venice 7 module is not installed in its socket.

Display board circuit

Refer now to Fig.2 for the display board circuit. This is based mainly on a backlit white-on-blue LCD module which has a display resolution of 160 x 80 pixels. It's powered from the +5V rail derived from REG1 on the main board, while its associated decoupling capacitors (1000μF and 100nF) are mounted close to its Vdd supply pin.

In addition, the display board carries the IR receiver module (IRD1), a blue ACKnowledge LED (LED3), a rotary encoder, eight pushbutton switches and a few minor parts. It connects to the main PC board via a 40-way ribbon cable which runs between CON17 and CON4. This carries all the power supply connections plus the connections from the microcontroller to the LCD module and the other parts.

Note that although the LCD module runs from a +5V rail, the microcontroller is powered from a +3.3V rail. Despite this, their logic threshold levels are compatible. This means that the microcontroller's 0-3.3V outputs can correctly drive the LCD module's 0-5V inputs. At the same time, a 5V output from the LCD module can be fed directly to one of the microcontroller's 3.3V inputs, provided it is 5V tolerant.

The LCD module's data lines (D0-D7) are bidirectional, depending on whether data is being written to or read from the LCD module. Since the LCD module runs from 5V and the microcontroller from 3.3V, these data lines are connected to the microcontroller's 5V tolerant pins.

The other lines required to drive the LCD module are as follows: R/W-bar (Read/Write), RS (Register Select), Vee (LCD Voltage), Vo (Contrast Adjust), CS-bar (Chip Select) and E (Enable). These are common to many other LCD modules and their meanings are as follows:

R/W-bar (Read/Write): when high, the microcontroller reads data from the LCD module; when low, the microcontroller writes data to the LCD module.

RS (Register Select): when low, the data register is accessed; when high, the instruction register is accessed. The data register is written with pixel information while the instruction register is written with the cursor position and other settings.

Vo (Contrast Control): varying the voltage on this pin controls the display contrast.

CS-bar (Chip Select): when low, the control chip inside the LCD module is selected and is ready to receive commands; when high, it ignores all commands.

E (Enable): when high, the LCD module's driver IC is enabled; when low, it ignores all commands;

Vee: this negative voltage output pin is generated by the LCD module from its supply voltage. It's used here to control the contrast via pin Vo.

The microcontroller controls these lines as appropriate. The E line is derived from two lines via NAND gate IC2d on the main board.

Note that although the LCD module we are using only has one CS line, other similar displays use two CS lines and so provision has been made to support these. During the development of the DAB+/FM Tuner, we used a 128 x 64 display with two CS lines, for example, before finally settling on the 160 x 80 display in the final version.

Contrast & brightness control

The brightness of the white LED backlight used in the LCD can be varied by the microcontroller. This is done via the LED+ (A) and LED- (K) pins of the LCD module (pins 19 & 20, respectively).

As shown, LED+ (the anode) is connected via CON17, CON4 and a 2.2Ω current limiting resistor to the +5V rail (see bottom of Fig.1). Similarly, LED- (the cathode) is connected via CON17 & CON4 to the drain of Q5, a 2N7000 field effect transistor (FET).

In operation, the backlight is driven using a PWM (pulse width modulated) waveform from pin 50 (OC3) of IC1. Its brightness is proportional to the duty cycle of this PWM signal which operates at a frequency of about 125kHz. This allows the duty cycle to be varied over an 8-bit range (256 levels) to control the display brightness.

The PWM signal is applied to Q5's gate via a 10Ω current-limiting resistor. There is also a 1kΩ pull-down resistor on pin 50 and this ensures that Q5 is turned off when there is no signal from pin 50 of IC1 (OC3). This situation occurs when the microcontroller is reset or is being programmed through ICSP (In Circuit Serial Programming), for example.

The display contrast can also be varied by the microcontroller using PWM. This is done using an independent PWM output at pin 46 (OC1) and this varies the contrast in conjunction with the circuit based on transistors Q1 & Q2.

It works like this: the PWM signal from pin 46 of the micro is used to pulse PNP transistor Q2 on and off via a 330Ω base resistor. In addition, there is a 56kΩ pull-down resistor and this keeps Q2 turned on whenever there is no driving signal from pin 46. Again, this occurs while the microcontroller is being reset and defines the "default" state for Q2.

When Q2 is off, the 330Ω resistor

Parts List For DAB+/FM Tuner

Chassis Parts

1 custom 19-inch rack style 1.5U metal instrument case with punched holes & screened lettering
6 right-angle metal brackets (supplied with case)
4 screw-on feet for case (Jaycar HP0830)
1 9V AC plugpack (500mA or higher) (Jaycar MP3027 or equivalent)
1 150mm-length 75Ω coaxial cable (RG59/U MINI with copper or tinned copper shield) (Farnell 1491575)
1 75Ω chassis-mount socket (for antenna)
1 SPST clip-in rocker switch, 20mm diameter (Jaycar SK0960)
10 yellow cable ties
1 M2.5 x 15mm self-tapping black screw (for securing stereo RCA socket to rear panel)
1 2.1mm bulkhead male socket (Jaycar PS0522)
1 0.7 metre length medium-duty yellow hook up wire
1 0.4 metre length black medium-duty hook up wire
1 40-way IDE HDD cable (Jaycar PL0946)

Main PC Board

1 PC board, code 01110101, 113 x 194mm
1 Venice 7 DAB+/FM radio tuner module
1 TOSLINK transmitter, 3.3V (Jaycar ZL3000)
2 14-pin IC sockets
2 8 pin IC sockets
1 40-pin dual header (Jaycar HM-3250) (to be cut – for connecting the Venice 7 module)
4 7-pin 0.1-inch straight female headers (for Venice 7 module socket)
2 8-pin 0.1-inch straight female headers (for Venice 7 module socket)
1 40-way PC-mount vertical IDC header (Jaycar PP1114)
1 DB9 PC-mount right-angle female socket (Jaycar PS0806)
2 TO-220 mini heatsinks (Jaycar HH8502)
1 RCA PC-mount vertical stereo socket (Jaycar PS0280)
1 7.3728MHz crystal (X1)
1 memory card socket (Jaycar PS0024)
1 2-way screw terminal blocks (5.08mm spacing)

Screws & nuts

8 M3 x 10mm tapped metal spacers
4 M3 x 25mm countersink head machine screws
5 M3 x 6mm machine screws (for regulators)
9 M3 metal nuts

Semiconductors

1 dsPIC33FJ256GP506(A)-I/PT microcontroller programmed with 0111010A.hex (IC1)
1 74HC00 quad NAND gate (IC2)
2 LM833N dual op amps (IC3 & IC4)
1 CD4066BC quad bilateral switch (IC5)
1 BC337 NPN transistor (Q1)
3 BC327 PNP transistor (Q2-Q4)
1 2N7000 FET (Q5)
1 7805 +5V regulator (REG1)
1 7905 -5V regulator (REG2)
2 LM3940-3.3 low-dropout regulators (REG3, REG4)
1 LM317T regulator (REG5)
3 1N4004 diodes (D1-D3)
1 3mm green LED 3mm (LED1)
1 3mm orange LED (LED2)

Capacitors

2 2200µF 25V electrolytic
2 1000µF 16V electrolytic
3 470µF 16V electrolytic
1 100µF 16V electrolytic
1 10µF tantalum
2 220nF MKT
8 100nF monolithic
9 100nF MKT
2 15nF MKT
2 2.2nF MKT
2 1nF MKT
2 33pF ceramic

Resistors (0.25W, 1%)

3 56kΩ	2 560Ω
6 33kΩ	4 510Ω
3 10kΩ	4 330Ω
2 4.7kΩ	4 220Ω
2 3kΩ	3 100Ω
1 2.2kΩ	1 10Ω
4 1kΩ	1 2.2Ω
2 620Ω	

DAB+ Front Panel Board

1 PC board, code 01110102, 277 x 57mm
8 SPST PC-mount tactile switches (square) (Jaycar SP0608)
8 black plastic caps to fit switches
1 graphics LCD module, 160 x 80 pixels
1 rotary encoder with switch (from Jaycar)
1 black anodised aluminium knob, 29mm diameter (Jaycar HK7011)
1 40-way PC-mount vertical IDC header (Jaycar PP1114)
1 28-pin single in-line strip (Jaycar HM3211) – (to be cut to 20 pins for connecting the LCD module)
4 M2 x 15mm machine screws (for mounting LCD)
12 M2 nuts (for mounting LCD)
12 M3 x 10mm machine screws, countersink head (for attaching brackets to front panel and front panel board to brackets)
6 M3 nuts (for attaching front panel board to brackets)
6 M3 flat nylon washers (for attaching front panel board to brackets)

Semiconductors

1 IR receiver (IRD1) (Jaycar ZD1952)
1 3mm blue LED (LED3)
4 1N4148 signal diodes (D4-D7)

Capacitors

1 1000µF 25V electrolytic
1 100µF 16V electrolytic
1 10µF 16V electrolytic
2 100nF monolithic

Resistors (0.25W, 1%)

2 1kΩ	1 100Ω
2 330Ω	

between its collector and Q1's base is effectively out of circuit. As a result, Q1's base voltage is pulled low by the associated 1kΩ resistor and so Q1 is off.

When Q1 is off, the voltage at the Vo (contrast) pin of the LCD module is close to the voltage at Vee (a negative voltage). In this state, the contrast is at maximum and it reduces as the Vo voltage approaches ground.

When transistor Q2 is on, Q1 is turned on via the 330Ω resistor. The voltage at Vo is now determined by the voltage divider formed by the 510Ω and 100Ω resistors between Q1's emitter and Vee. Thus, by varying Q2's duty cycle (and hence Q1's duty cycle), the voltage at Vo can be controlled to set the contrast.

Front panel controls

As previously stated, the front panel controls include eight SPST momentary switches, an SPST power switch and a rotary encoder with pushbutton action. The latter is used to vary settings, select stations and adjust the volume. It can also be used to navigate through the menu system.

The rotary encoder outputs two signals at A and B, which are out of quadrature. These outputs are pulled up by two 1kΩ resistors and connect to two external interrupt inputs of IC1 (INT2 & INT3 at pins 43 & 44, respectively). These interrupts are triggered on either a high to low or low to high edge and this allows the microcontroller to keep track of the rotary encoder and determine whether it is being turned clockwise or anticlockwise.

In addition, the rotary encoder has a switch which is activated by pressing on the shaft (ie, pushbutton action). This switch, together with the eight SPST momentary switches (S1-S8), is part of a 4 x 4 scanning matrix. Four lines (KC0-KC3) are configured as digital outputs, while the other four (KR0-KR3) are configured as digital inputs.

Lines KC0-KC3 are connected to the switches via four signal diodes (D4-D7), to effectively make them open collector outputs. This is done because these four lines are multiplexed with LCD module lines D0, D1, R/W-bar and RS. In addition, the diodes prevent a short circuit if two switches on the same column are pressed simultaneously.

In operation, each of the four output lines (KC0-KC3) is periodically brought low by the microcontroller (while the rest are high). Meanwhile, the four input lines KR0-KR3 are connected to separate "interrupt on change" lines of IC1 (CN5, CN4, CN3 & CN2 respectively at pins 13-16). These lines have internal weak pull-up resistors enabled and any change on the pin (as happens when a button is pressed) generates an interrupt. The microcontroller can then determine which button was pressed and take the appropriate action.

Where To Buy A Kit Of Parts

A complete kit of parts for the DAB+/FM Tuner will be available from Jaycar Electronics – Cat. KC5491. This kit will be complete and will include the Venice 7 radio module, double-sided plated-through PC boards, a pre-punched custom steel case with screened lettering and the remote control. The main board will be supplied with the dsPIC microcontroller soldered in place.

Kits will be available by early December and can be pre-ordered at your local Jaycar store.

Indicator LEDs

There are three indicator LEDs in all, two on the main board (LEDs 1 & 2) and one on the display board (LED3).

LED1 indicates that power is connected, while LED2 indicates when there is activity on the memory card. Neither of these LEDs is visible from outside the case and they are used solely for diagnostic purposes. They are not essential to the normal operation of the DAB+/FM Tuner.

These two LEDs are driven by I/O pins RB10 & RB13 (pins 23 & 28 respectively) of IC1 via 220Ω current limiting resistors. In addition, pin 28 has a 33kΩ pull-down resistor.

LED 3 (blue) protrudes through the front panel (to the left of the LCD) and is used to ACKnowledge infrared activity from the remote control. It is controlled using a PWM (pulse width modulation) signal from output OC7 (pin 54) of IC1. The 330Ω resistor in series with its cathode provides current limiting to set the maximum brightness.

In addition, varying the brightness of the LCD module's backlight also affects the brightness of LED3.

Remote control

The DAB+/FM Tuner can be controlled using the supplied remote control (see lead photo). This uses an NEC 32-bit PWM code, meaning that the width of the pulse determines whether the transmitted bit is high or low.

Although it uses a 32-bit code, only 16 bits are significant. The rest are the complements of the others. This adds redundancy and makes the code less prone to errors. It also ensures that each word has the same period.

Alternatively, you can use a universal remote control that's RC5 compatible. RC5 is an infrared protocol that was initially developed by Philips and is now quite commonly used. It is a bi-phase encoded code, with the bits represented by high-to-low or low-to-high transitions (it is self clocking).

The DAB+/FM Tuner has been designed to work with both the NEC and Philips codes in case the supplied remote control develops a fault and is no longer available. If that happens, you can still control the tuner using a universal remote that's capable of transmitting RC5 codes (most do).

You can also define the codes that correspond to the button functions using the menu system, as described in a future article.

Infrared receiver

The infrared receiver (IRD1) is mounted on the display board and receives signals from the remote through a small hole in the front panel. IRD1 amplifies, filters and demodulates these signals before feeding the data to RD1 (pin 45) of IC1 via a 330Ω resistor.

Power for IRD1 is derived from the +5V rail and is filtered using a 100Ω resistor and a 10μF electrolytic capacitor.

RD1 of IC1 is 5V tolerant and triggers an interrupt on a high to low edge. An edge trigger is used to start the signal decoding. This decoding takes up only a small amount of processor time and times out after a few seconds, making the decoding very efficient.

Next month

That's all we have space for this month. Next month, we'll show you how to assemble the two PC boards and install them in a case. SC

BUILD IT NOW IN TIME FOR YOUR CHRISTMAS EXTRAVAGANZA!

DIGITAL LIGHTING CONTROLLER

Part 1 – by Nicholas Vinen and Jim Rowe

Want one up on your neighbours? Instead of a static Christmas Lights display (*so* passé!) now you can have the ultimate in Christmas extravaganzas. This amazing controller will bring your Christmas lights to life, making them flash, dim up and down, you name it, all in time with your favourite Christmas music. It's easy to build, easy to connect and, best of all, easy to program!

OK, we have to admit it. We first had this idea after watching Chevy Chase's "Christmas Vacation". Then it was given further impetus by a YouTube clip we saw a couple of years ago. It's taken a while to put the idea into practice!

You've probably seen the clip we're talking about. Just one version of it has had nearly seven million hits! But if you haven't and/or if you'd like to see the inspiration – and get some idea of what this will do for you, check out www.youtube.com/watch?v=rmgf60CI_ks (or simply enter "Christmas Lights" on YouTube).

Actually, we lie: we're pretty sure that controller only had about 12-16 channels. Ours has up to 32, so you'll be able to put that to shame.

Just imagine the neighbours – they'll be as amazed as everyone else who stops to admire your handywork this festive season.

There are certainly some amazing displays this time of year. But for the most part, they're static. Most don't DO anything except look pretty. With this controller, yours can look pretty AND look spectacular at the same time.

We know that quite a number of readers have used SILICON CHIP's DSP Musicolour Lightshow (June-September 2008) to control their Christmas Lights, flashing them in time with music. That's fine, of course, if all you want is flashing lights.

Like the Musicolour, this unit has multiple high-current Triac outputs capable of phase-based brightness control. But that's where the similarities end. With this new controller (or more properly called a sequencer) you can program in specific lighting patterns and movements, similar to the

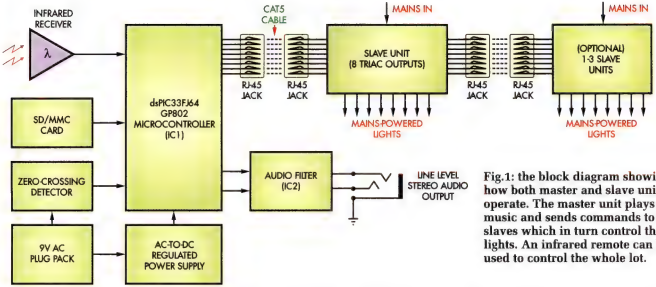


Fig.1: the block diagram showing how both master and slave units operate. The master unit plays the music and sends commands to the slaves which in turn control the lights. An infrared remote can be used to control the whole lot.

YouTube clip above.

We decided that for this application, rather than attempt to synchronise the light show with music being played from another source, it would be best to have the Controller itself play the music AND sequence the lights. This makes for a self-contained project which will always keep the light sequence strictly in time with the music.

The hardware

The hardware is split into two sections. One is a small plastic box containing the master unit while a larger instrument case houses the slave unit. Between one and four slave units, each of which controls up to eight channels, can be connected to the master.

The master unit, which is controlled via a hand-held remote, plays the music and a sequencer file (which you set up) from an MMC (MultiMedia Card), SD (Secure Digital) card or SDHC (high capacity) card. It sends serial commands to the slaves via a Cat5/6 cable with up to 30m between the units.

Splitting the project into two parts has two advantages. Firstly, only the slave units contain mains wiring, making it easier to build them safely. Secondly, you can build the number of outputs you need. One slave with eight channels will drive a small light show while four slaves, totalling a whopping 32 channels, will create a lighting spectacular worthy of a Broadway hit!

Each slave has eight mains output sockets but you can use as many or as few of these as required.

While each of the eight slave channels can drive lights up to 1200W at 230V AC (5A), the total amount of power allowed per slave unit is 2300W, limited by the 10A input socket and fuse. The power figures are halved for 115V AC mains.

Since we have designed this project for use anywhere in the known universe, mains supply frequencies of 50Hz and 60Hz are supported.

Because the slave power limit is 2300W, if you are using all eight channels with identical lights, the

The master controller fits into the smaller box on top, while each 8-channel slave unit requires the larger case below. Up to four slaves can be connected.

Features

Audio THD+N	0.06%
Audio Signal-to-Noise Ratio	65dB
Audio sample rates (kHz)	11.025, 12.0, 22.05, 24.0, 32.0, 44.1, 48.0
Audio file formats	WAV format, 16 bit PCM, mono or stereo
Music capacity	At least 4GB (ie, more than six hours at CD quality)
Playback order	By directory order, alphabetically or random (shuffle)
Number of light "channels"	32 (max. 4 slaves = 32 channels)
Light power per channel	25-1200W (230V AC) or 12-600W (115V AC)
Total light power (four slaves)	9200W (230V AC) or 4600W (115V AC)
Extra features	Remote control, Filament preheat, Volume control
Infrared formats supported	Philips RC5 12-bit, NEC 16-bit

maximum power per channel would be 287W (1.25A).

We don't believe that will normally be a problem because (a) most Christmas Tree "bud" light strings are only 10-50W or so and (b) even PAR38 coloured floodlights are usually only 100W.

The 1200W per channel figure is only possible if some channels are left unused or have lighter loads.

If you wanted to run four slave units giving up to 32 channels, you could do so by spreading them over separate same-phase mains circuits, each of which is normally limited to 15A.

That does NOT mean running four slaves from the one powerboard or double adaptors! (Don't laugh – we've seen much worse . . .)

While a personal computer is used to initially set up the music files and sequences, no PC is required for playing the music or controlling the light sequence. This results in a simplified set-up with increased safety and less power consumption.

The music output

Finally, the master unit also has a line-level audio output to drive virtually any amplifier, perhaps with outdoor speakers so everyone can enjoy the music and lightshow.

Perhaps your neighbours may not be too happy for you to set up loudspeakers playing Christmas music continuously along with your light show (bah, humbug!).

As suggested by a reader last month, one clever solution is to wire up a small FM transmitter (build from a kit or purchased as a retail device) so that people can tune in and listen in their cars or even their mobile phones while watching the show.

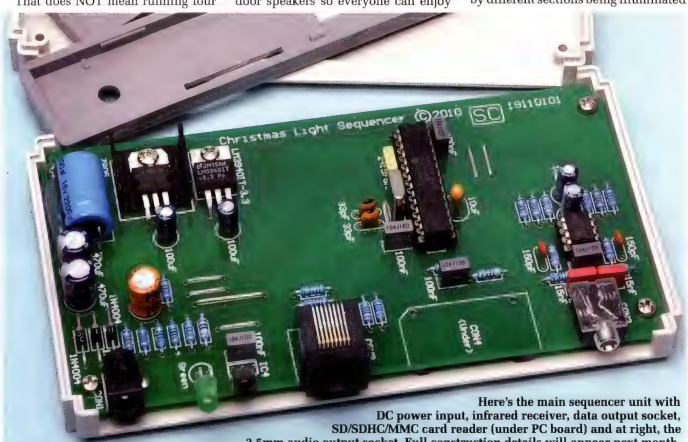
A sign out the front could say "to listen in, tune your car radio to 88.X MHz" (or something similar). Just make sure you don't pick a frequency occupied by an FM radio station in your area!

Apart from Christmas Lights?

This project isn't just limited to a Christmas Light application.

It can be used any time that you want lights to be controlled synchronously with audio. For example it could be used in a museum exhibit, where pressing a button activates narration explaining the exhibit while the appropriate sections are lit up in turn.

Or it could be used as part of an art project, where music and/or narration/music/sound effects are accompanied by different sections being illuminated



Here's the main sequencer unit with DC power input, infrared receiver, data output socket, SD/SDHC/MMC card reader (under PC board) and at right, the 3.5mm audio output socket. Full construction details will appear next month.

or devices powered up and down.

Another suggestion is to provide mood lighting or even to switch lights on and off over the course of a day when you are away from home, so that it looks like somebody is still there.

Not only will you achieve a much more realistic light pattern than with a switchboard (the usual method), you can also have music playing to make you home look *really* occupied!

We've designed the switching so that theoretically other mains devices (eg, small motors, etc) can also be controlled but of course, if this is done, "dimming" via phase control must not be attempted! It really is intended to be used with resistive loads, à la lights.

How it works

Refer to Fig.1, the block diagram. At the heart of the project is the dsPIC33FJ64GP802 microcontroller from Microchip. It has 64KB of FLASH program memory, 16KB of RAM (random access memory) and will processs up to 40 MIPS (millions of instructions per second).

This IC is responsible for controlling all the functions of the sequencer, including music playback and Triac triggering/phase control (see panel).

During a light show, the dsPIC chip reads one WAV audio file at a time from the attached MMC/SD/SDHC card and plays it back using its internal digital-to-analog converter (DAC). The output of the DAC goes through a filter which removes some of the digital noise.

The resulting signal level is around 1V RMS, which is compatible with most amplifier "aux" (line level) inputs. As well as a hifi/stereo power amplifier, it could be connected to an FM transmitter, headphone amplifier, mixer, etc.

Power for the master module comes from a 9V AC plugpack. There are two reasons why we are using an AC plugpack rather than DC.

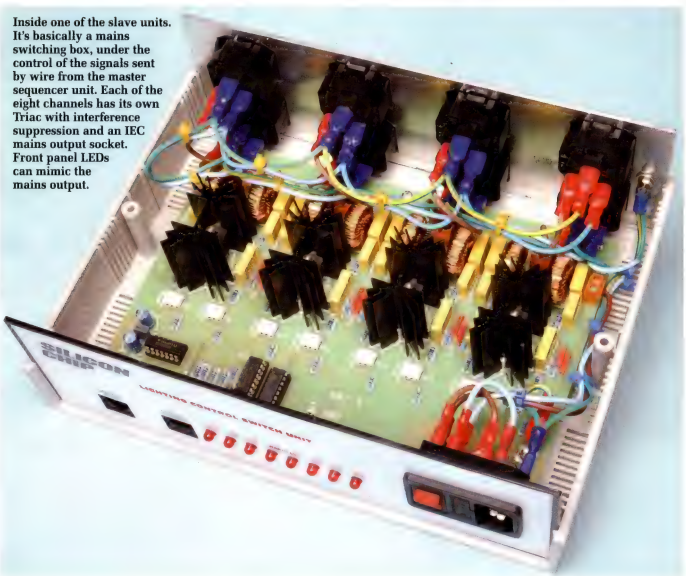
Firstly, we need to know when the mains zero-crossing events occur to enable phase control of the lights, for brightness adjustment.

Secondly, this makes it easy to generate balanced supply rails for the audio filter op amps. A higher voltage plugpack cannot be used as that risks exceeding the op amp supply ratings.

The power consumed from the plugpack depends upon how many slave modules are connected and the specifics of the light sequence but as a rough guide, with one slave module and eight active light channels it can be expected to below 250mA/2.5W.

The zero-crossing detection is done by IC1's internal comparator. This compares a reduced amplitude signal from the plugpack AC output to a half-supply rail, resetting a timer each time they cross.

By measuring how long this timer



Inside one of the slave units. It's basically a mains switching box, under the control of the signals sent by wire from the master sequencer unit. Each of the eight channels has its own Triac with interference suppression and an IEC mains output socket. Front panel LEDs can mimic the mains output.

runs, IC1 can determine the mains frequency (50Hz or 60Hz). It needs to know this in order to convert the desired phase angle for each light to a time delay for Triac triggering.

Synchronised sequence playback

When the microcontroller opens a WAV file for output, it also looks for a file with the same name but a different extension (.lsq). This file contains the light sequencing information which you have prepared to demonstrate your lighting brilliance (OK, pun intended!).

It is processed at the same rate as the WAV file is played so that they remain synchronised. The information it contains indicates when to switch lights on and off, when to change their brightness and what the new brightness settings are – either a fixed percentage of full brightness or indeed fading up/down.

At the appropriate times during each mains half-cycle, IC1 sends serial data out over the RJ45 jack connection. This is carried to each slave module in turn, where the serial data is latched and used to determine which Triacs to trigger. As a result, IC1 controls the lights in each slave module as determined by the sequence file.

This sequence file is generated with the Windows software we have developed, which will be available from the SILICON CHIP website next month (at the same time as the article containing the construction details).

We will also provide source code for this software for any users who are interested in porting it to other operating systems like Mac OS X or Linux.

The light sequence can be generated manually, by using the GUI to indicate at which point in the music to change the output light states.

Or, to save time, the control for some light channels can be automatically derived from the music itself over a given time period, with adjustable parameters to determine how it behaves. The result can be used as-is or can be further edited to your satisfaction.

User interface

The behaviour of the master module is controlled in two ways. Firstly, its default setting are specified in the optional configuration file which is stored on the MMC/SD/SDHC card.

This allows you to determine whether the music files are played back in order or randomly, which file to start with, whether playback starts immediately when power is applied or must be triggered manually and several other options which control the slave unit behaviour (more on those later).

Further control of the master module is made via the infrared remote control. Available functions include stopping, starting and pausing playback, changing audio tracks, adjusting the volume, playing a specific track, changing the playback order and so on.

The default remote control codes are set up to suit common universal remotes but they can also be changed using the configuration file.

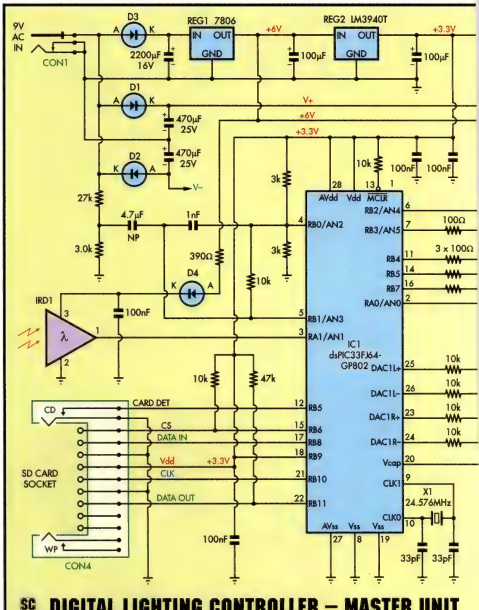


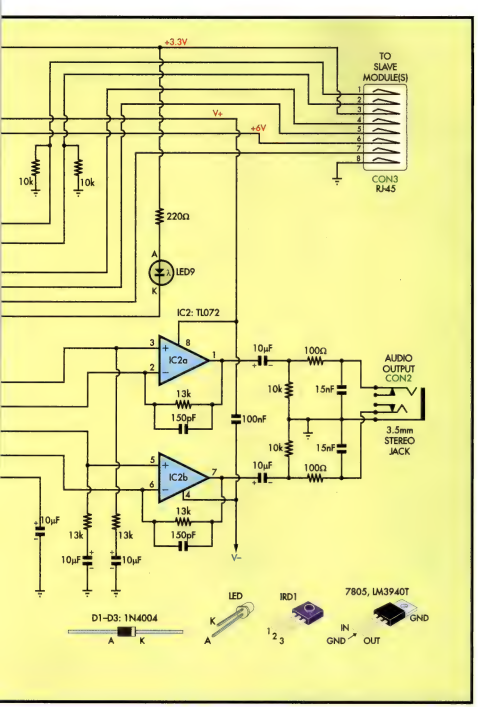
Fig.2: the master unit circuit. At its heart is IC1, a dsPIC running at around 40MHz. IC2 provides gain and filtering for the audio output. Communication with slave units is via CON3 while the music and sequence data are read from the card plugged into CON4.

Cabling

We chose Cat5 cable to connect the slave modules because it is readily available in a variety of lengths, can be made to length, has an appropriate number of conductors (eight) and is weatherproof.

This should enable constructors to easily connect multiple slave modules in different locations, to control a large array of lights.

Because the serial data is buffered by each slave module, this does not limit the total cable length and so 30m cable



runs between each unit are possible. In fact longer cable runs may work fine but 30m is the longest pre-formed cable that is commonly available.

Our test set-up is as follows. We ran a 2m Cat5 patch cable from the master unit to a wall socket which was wired to another wall socket approximately 20m away. Including the vertical runs and other diversions the actual cable run is at least 25m. We then connected a 5m Cat5 patch cable from the other wall socket to the slave unit.

There were no apparent serial data errors over this distance and the voltage drop on the 6V line was acceptable (a little over 100mV with all eight lights on). Four such cable runs would produce a total of around 400-500mV loss on the 6V line.

In normal circumstances, assuming typical device characteristics, this will leave a high enough voltage at the last slave to reliably trigger its Triacs. However to be safe it is best to keep the total cable run under 50m if possible, especially if wall sockets are involved.

Firmware

While the hardware of both the master and slave modules is fairly straightforward, the software required for IC1 to perform all these tasks is complex. We will not go into great detail in this article, however the source code will be available for download along with the HEX file.

During playback, both the WAV and sequence files are read off the MMC/SD/SDHC card synchronously, ie, the software waits for each data packet to arrive. Therefore, the other functions which must be handled simultaneously – DAC output, infrared sensing, zero crossing detection, phase control, etc – must be interrupt driven.

Direct Memory Access (DMA) is used for the DAC output and SD card access to improve efficiency.

A number of software modules are required to enable the various functions.

These include the MMC/SD/SDHC card driver, FAT file system support, WAV file reader, DAC driver, sample rate and clock speed setting functions, infrared decoding, mains phase synchronisation and serial output, audio state playback logic and slave chain length sensing (which uses the internal ADC).

Slave control

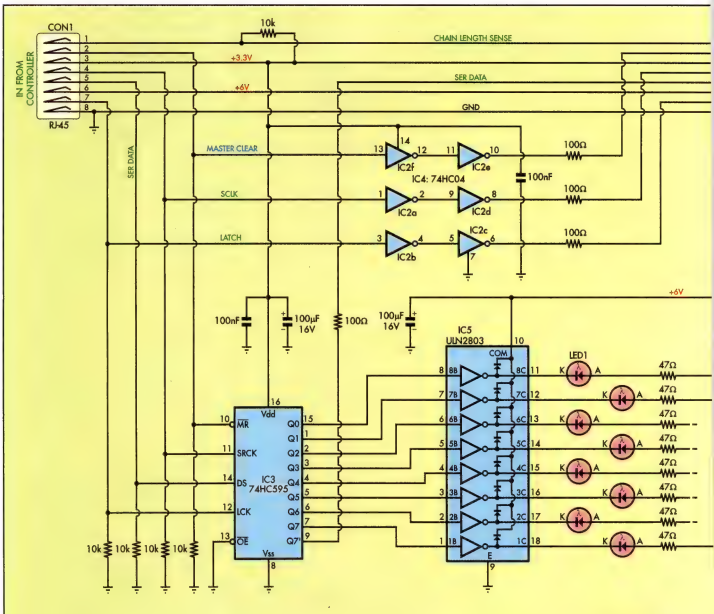
The reason that the software calculates the number of attached slaves is that if there are only one or two, it can use the lowest possible serial frequency (72kHz) and only needs to transmit 16 bits (one word) per trigger point.

With three or four slaves, the serial frequency is increased to 96kHz so that 32 bits (two words) can be transmitted at each trigger point and will be finished before the next trigger point is reached.

These trigger points are spaced approximately half a millisecond apart and there are up to nineteen trigger points per mains half cycle. In order to allow for smooth brightness control (256 levels), the trigger point used for a given light is "dithered", ie, it is rapidly toggled back and forth to give intermediate brightness levels.

Because of the filament heat persistence and the persistence of our vision, this rapid brightness variation is not visible. This scheme reduces the required serial rate and makes the microcontroller's job easier as it can more often send the trigger even for multiple lights together in a single command.

In choosing when to trigger a given TRIAC, the microcontroller also takes account of the fact that the amount



DIGITAL LIGHTING CONTROLLER SLAVE UNIT

Fig.3: the slave unit uses IC1, a serial-to-parallel latch, to decode the control data. Its outputs drive IC3, an eight Darlington array, which switches current through the optocoupler LEDs (OPTO1-8). These control TRIAC1-8 and ultimately the lights. The optocouplers and TRIACs are both equipped with snubber networks to prevent false triggering and an LC filter to reduce radiated EMI. IC4 buffers the serial stream to the next slave unit.

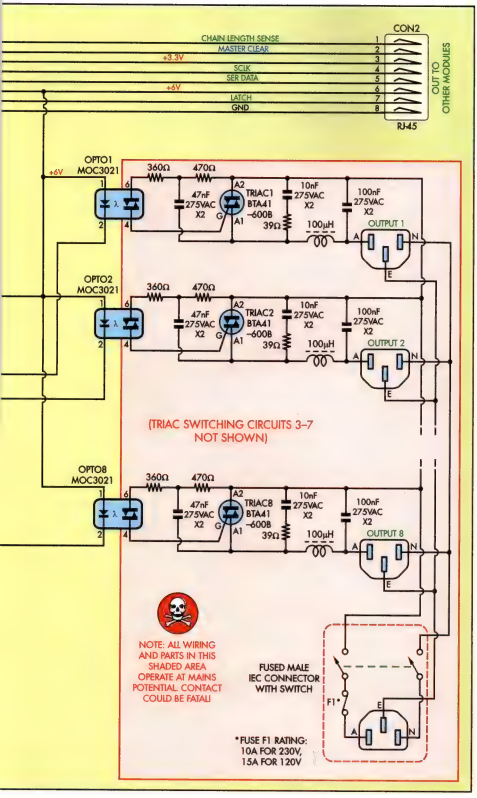
of power delivered does not vary linearly with the trigger phase angle. It has a lookup table which allows it to calculate the percentage of full power that a light will receive for each given trigger period .

This is compared to the desired brightness level and the dither error from the last trigger event in order to calculate the appropriate trigger point.

Because the master module senses mains zero crossings via its AC plugpack supply, by default it assumes that the slave modules are all on the same mains power phase as it is.

This will be true in the vast majority of cases as most residences use a single phase for all power outlets. While it is possible to run the controller across multiple phases (indeed, the software can handle this) in the interests of safety and simplicity we do not recommend operation on more than one phase.

Another configuration option which affects slave behaviour is the filament preheat control. Filament preheating



means that when lights are off, their power will not drop to zero.

Instead, the filaments are run just below red heat which means that high repetitive surge currents are largely eliminated when they are being turned on and off frequently.

Two options are provided. One specifies which outputs have lights that require filament preheating and the other determines what percentage of full power is delivered during the off-state.

Circuit description

Refer to Fig.2 for the master unit circuit diagram. Power from the 9V AC plugpack is delivered via CON1 then rectified separately for two supplies. Diodes D1 & D2 form a full-wave voltage doubler, charging the two 470µF filter capacitors to generate an unregulated split supply of approximately ±13V. This is used to power the op amps.

At the same time, diode D3 half-wave rectifies the AC input, charging a 2200µF filter capacitor for the digital supply. This is regulated to 6V by REG1 and powers the optocouplers in the slave modules.

It is further regulated (by REG2) down to 3.3V for the remaining digital components, including microcontroller IC1 and the digital logic in the slave modules.

The 6V rail voltage is dropped by D4 and then further by the 390Ω resistor to provide a 4.5-5.5V supply for the infrared receiver. This assumes that its current consumption is in the range of 0.5mA-1.5mA, which is that of the receivers specified in the parts list. The 390Ω resistor and the 100nF capacitor filter its supply so that any digital switching spikes do not upset its internal amplifier.

Pins 4 and 5 are connected to IC1's internal voltage comparator and this is used for mains zero crossing detection. The AC input voltage is divided (with a 10:1 ratio) by the 27kΩ and 3kΩ series-connected resistors, resulting in a 0.9-1.1V AC sine wave at their junction.

Two 3kΩ resistors hold pin 4 of IC1 at approximately 1.65V (half the 3.3V supply). The reduced amplitude sine wave is AC-coupled to pin 5 of IC1 and also biased to the 1.65V level via a 10kΩ resistor.

For half of each mains wave, the voltage at pin 5 is higher than the voltage at pin 4 and the rest of the time it is lower. IC1's comparator generates a software interrupt every time this changes, allowing it to synchronise a timer to the zero crossing event. In reality, the voltage at pin 4 does not stay at exactly half supply as current flows back through the 10kΩ biasing resistor but this does not affect the zero crossing detection.

Since comparators tend to have an offset voltage between their inputs, the zero crossing detection is only accurate to within about ±2%. This is taken care of by the software with the insertion of a "dead zone" around the zero crossing point. The 1nF capacitor between pins 4 and 5 suppresses mains

Phase controlled Triacs, serial data

In essence, this Digital Lighting Controller can be thought of as a multi-channel light dimmer, all under the control of the dsPIC micro which in turn is responding to commands written for a particular piece of music stored on the SD card.

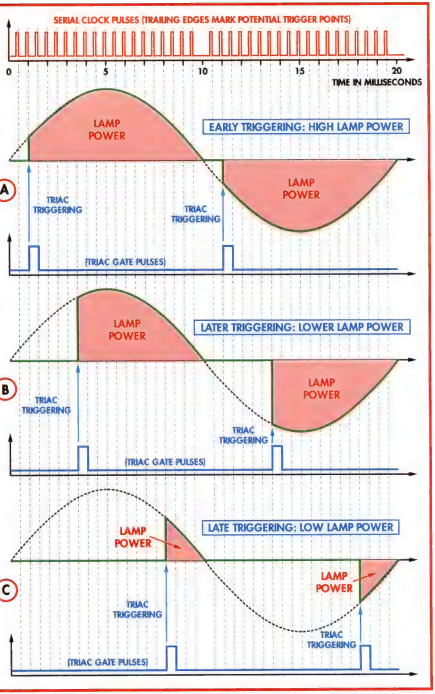
But how do the light dimmers work? Just the same as the light dimmers in your home, they are based on a Triac, a four-layer semiconductor device that can switch high voltage AC. When triggered, a Triac stays on until the voltage across it drops to zero or reverses.

We vary the power fed to the lamps by triggering the Triac earlier or later in each mains half-cycle; the more power the lamp gets, the brighter it will be. This is known as "phase control" as we are varying the portion of the mains waveform which the lamps receive.

The accompanying diagram illustrates Triac triggering on 230VAC mains waveforms, A, B and C. A corresponds to high power since the Triac is on for most of the time. B corresponds to slightly less power, as the Triac is triggered later in each AC half cycle. And C corresponds to the lowest power normally used in the Controller, equivalent to the "filament preheating" referred to elsewhere.

Note that while only three Triacs are depicted here, the Controller can drive up to 32 channels (in four slave units).

The serial data stream at the top of the diagram is fed to the serial-to-parallel latch (IC5) and the trailing edge of each data pulse defines the start of a gate signal fed to each Triac. Each Triac's gate signal (trigger) is on for the time between successive serial data pulses or around 0.5ms. Each Triac stays on for the rest of the half-cycle due to its latching action.



and power supply noise, preventing false comparator triggering.

Infrared receiver IRD1 detects infrared light pulses at the appropriate frequency (around 36kHz). Its logic level output goes straight to IC1's RA1 input (pin 3). This pin is configured to generate an interrupt on a level change and this triggers a decoding sequence whenever infrared pulses are received.

The MMC/SD/SDHC card socket CON4 is wired directly to IC1, which uses an internal SPI peripheral to communicate with the card. The MMC/SD/SDHC card is powered from the regulated 3.3V rail. Pull-up resistors are provided for the card's CS and DATA OUT pins in order to ensure it is not activated at the times when IC1 is not operating (eg, when it is powering up or reset).

Input RB5 (pin 12) has a weak internal pull-up enabled. The card socket connects its card detection (CD) pins together if a card is inserted, pulling IC1's pin 12 low and triggering its communication initialisation routine.

Audio output

Audio output is generated from IC1's internal 16-bit DAC and then passes to IC2, a dual op amp. The left/right DAC outputs are differential, meaning that when DAC1L+ swings up, DAC1L- swings low.

For best audio quality, these signals should be subtracted to form the final audio output. IC2a and IC2b are configured as differential amplifiers with a gain of 1.3 (13kΩ/10kΩ), resulting in an output level of around 1V RMS.

The two 10µF capacitors in series with the 13kΩ resistors charge to the DAC's average output voltage and form a virtual ground for the differential amplifier input dividers. They result in a high-pass filter with a -3dB point at around 1Hz.

Parts List – Digital Lighting Sequencer/Controller

Master module

1 PC board, coded 16110101, 148 x 80mm
1 front panel label, 145 x 20mm
1 2.5mm PC-mount DC socket (CON1)
1 3.5mm PC-mount stereo switched socket (Jaycar PS0133, Altronics P0092) (CON2)
1 low profile RJ-45 socket (Altronics P1448) (CON3)
1 surface mount MMC/SD/SDHC card socket (Altronics P5720) (CON4)
1 24.576MHz crystal
1 ABS plastic instrument case, 86 x 155 x 30mm (Altronics H0377)
4 nylon washers
4 No.4 x 9mm self-tapping screws
1 9V AC plugpack 500mA+ (Altronics M9231, Jaycar MP3027)
1 SD, MMC or SDHC card, at least 1GB recommended
15cm tinned copper wire

Semiconductors

1 dsPIC33FJ64GP802 microcontroller (IC1) programmed with 1911010A.hex
1 TL072 dual op amp (IC2)
1 infrared receiver (IRD1) (Jaycar ZD1952, Altronics Z1611/Z1611A)
1 7806T regulator (REG1)
1 LM3940IT-3.3 regulator (REG2)
1 green 5mm LED (LED9)
4 1N4004 diodes (D1-D4)

Capacitors

1 2200µF 16V
2 470µF 16V
2 100µF 16V
4 10µF 16V
1 1 0µF 16V tantalum
1 4.7µF non-polar (NP)
5 100nF MKT
2 15nF MKT
1 1nF MKT
2 150pF ceramic
2 33pF ceramic

Resistors

1 47kΩ	1 27kΩ	4 13kΩ	11 10kΩ
3 3kΩ	1 390Ω	1 220Ω	6 100Ω

WARNING!

This is a mains-operated device. Construction should not be attempted unless you have knowledge of and experience in building mains-powered projects. The slave unit has areas of the PC board where components and tracks are at mains potential. Contact with live wiring could prove fatal.

Slave module (parts for one module [eight channels] only)

1 PC board, code 16110102, 216 x 157.5mm
1 plastic instrument case, 260 x 190 x 80mm (Jaycar HB-5910, Altronics H0482)
1 aluminium rear panel for above case, 2mm thick
1 front panel label, 240 x 71mm
1 rear panel label, 240 x 71mm
2 low profile RJ-45 sockets (Altronics P1448)
8 100µH 5A mains-rated inductors (Jaycar LF1270, Altronics L6622)
4 heavy-duty PC-mount TO-3P heat sinks (Jaycar HH8526, Altronics H0667)
5 2-way mini terminal blocks (5.08mm pin spacing)
1 1.5mm panel snap-in male IEC mains connector with fuse and switch (Altronics P8341)
8 chassis-mount female IEC mains connectors (Altronics P8326)
15 blue fully-insulated 6.4mm female spade crimp lugs
17 red fully-insulated 6.4mm female spade crimp lugs
1 chassis-mount male spade lug
1 5.3mm eyelet crimp lug
20 small nylon cable ties
6 No.4 x 9mm self-tapping screws
22 M3 x 10mm machine screws
24 M3 shake-proof washers
24 M3 nuts
2 10A M205 fuses (1 spare)
1.2m mains-rated green/yellow (earth) wire
1.1m mains-rated light blue (neutral) wire
0.8m mains-rated brown (active) wire
40cm tinned copper wire
15cm x 2.5-3mm diameter fibreglass sleeving (Jaycar WS5504, Altronics W0852)
Cat5, 5e or 6 cable with length to suit installation

Semiconductors

1 74HC595 serial-to-parallel latch IC (IC3)
1 74HC04 hex inverter IC (IC4)
1 ULN2803 octal Darlington array (IC5)
8 red 5mm LEDs (LED1-8)
8 MOC3021 Triac optocouplers (OPTO1-8)
8 BTA41-600B insulated tab 40A Triacs (Triac1-8)

Capacitors

2 100µF 16V
8 100nF MKT X2 250V AC
2 100nF MKT
8 47nF MKT X2 250V AC
8 10nF MKT X2 250V AC

Resistors

5 10kΩ	8 470Ω	8 360Ω	4 100Ω
8 47Ω	8 39Ω		

The bootloader

The master module firmware includes a "bootloader". This allows the software on the master module to be updated without requiring a programming tool.

When the device powers up it looks for a HEX file on the memory card. If it is present, the contents are read and verified, then written into the FLASH program memory.

The main program runs after the programming is complete, or immediately if there is no HEX file. The main program can re-program the bootloader if necessary, allowing the whole chip to be updated.

The FLASH memory is divided in two. The bootloader resides at the end of memory, (addresses 0x9000 – 0xABFF, 10.5kB). The main program is at the start (addresses 0x0000-0x8FFF, 54kB).

The bootloader program incorporates the MMC/SD/SDHC card reader code along with the FAT file system and FLASH memory programming routines. Because the interrupt vector table is stored in FLASH memory at 0x0000-0x01FF and therefore is part of the main program, the bootloader does not use any interrupts.

Because the reset vector (which must point to the bootloader) is within the interrupt vector table, when the first page of memory is programmed, the reset vector address is overridden.

If the reset vector were corrupted during the programming process, eg due to a power failure, the bootloader would no longer work. Before re-programming it, the bootloader program checks that AC power is present via the zero crossing detection circuitry.

The 2200µF capacitor provides enough power to finish programming even if AC power is lost after that point. A similar check is made in the main program before re-programming the bootloader.

The 150pF capacitors in parallel with the 13kΩ feedback resistors roll off the op amp gain to form a low-pass filter with a -3dB point around 80kHz.

This active filter removes much of the high frequency switching noise from the delta-sigma DAC architecture, which is mostly above 2MHz (for CD quality audio).

The output of each differential amplifier is AC-coupled to make it ground-referenced, then further filtered with a passive low-pass RC filter consisting of the 100Ω resistors and 15nF capacitors. This is more effective than the active filter at frequencies above IC2's bandwidth (2.3MHz at this gain setting) which can be coupled via the 150pF capacitors.

The 100Ω resistors also isolate IC2's outputs from any cable capacitance and provide current limiting should the outputs be shorted to ground or to each other. CON2 is the audio output connector and accepts 3.5mm stereo jack plugs.

Crystal X1 provides a reference frequency to IC1 for the DAC timing. This allows it to operate the DAC at a frequency very close to the sample rate of the file being played back. IC1 operates at 39.552MHz when the audio sampling rate is 44.1kHz, 22.050kHz (half rate) or 11.025kHz (quarter rate). This is divided by 14, 28 or 56 to provide the DAC oversampling clock, which is 64 times the sample rate. The sample rate error is less than 0.1%.

Alternatively, IC1 operates at 39.936MHz for sample rates of 48kHz, 24kHz (half rate) or 12kHz (quarter rate). This is divided by 52, 26 or 13 (respectively), resulting in exactly 64 times the sample rate. For 32kHz sample rate, the clock is 38.912MHz and the divider is 19, also resulting in an exact DAC clock.

While IC1 runs from the 3.3V supply, its core actually runs at 2.5V. This is generated by an internal regulator. Its output is filtered by the 10µF tantalum capacitor connected between pins 19 and 20.

The master module communicates with the slave(s) via 8-pin RJ-45 connector CON3. This provides the low voltage slave power supply, serial communications and slave chain length sensing. 3.3V is provided for the slave digital logic (pin 3) and 6V for driving the optocouplers (pin 6) plus a common ground (pin 8).

The same connector is used for the serial communication with data (pin 5) and clock lines (pin 4), chip select/latch (pin 7) and master clear (pin 2). Pin 1 is for chain length sensing and is used by the master module to determine how many slaves are connected. Each slave module has a resistor between this pin and the 3.3V supply and these form a voltage divider in combination with the 10kΩ resistor on the master board.

Each serial output has a 100Ω resistor between the microcontroller output and the connector pin. This combines with the cable capacitance to form an RC filter which helps to limit reflections and ringing in the cable as well as reduces electro-magnetic interference (EMI) from the cables by limiting the signal rise and fall times.

Normally, Cat5 cable is used for high speed network signalling and the twisted pairs in the cable are driven differentially. This allows for high speed communication with minimal crosstalk and interference.

However, we are not using differential signalling so we must limit the serial speed in order to maintain sufficient signal integrity. This is not a problem as a serial clock of 100kHz is sufficient for this application.

LED1 provides the only direct user feedback from the master module and is driven from pin 2 of IC1. It can be turned on or off, set to an intermediate brightness or flashed at various rates to convey different information to the user.

Slave module circuit

The slave module receives serial data from the master module to control when each of the eight Triacs are triggered during each mains half-cycle. A 74HC595 serial-to-parallel latch IC (IC3) decodes this serial data. Each of the incoming lines is terminated with a 10kΩ resistor to help to drain the cable capacitance when a line is driven low.

The latch drives a ULN2803 octal Darlington transistor array (IC53) which acts as a current buffer to provide sufficient drive strength for the optocoupler LEDs. These optocouplers have two purposes. Firstly, they isolate the low voltage signal side of the circuit from the mains side so that lethal voltages can not be conducted back to the master module over the Cat5 cable (or shock somebody touching the connector).

Secondly, they make triggering the Triacs easy as all that is required is for sufficient current to pass through their internal infrared LED. The minimum guaranteed trigger current is 15mA and the 74HC595 is not rated to provide this much current directly, hence the Darlington array. When an output from IC1 goes high, the Darlington in IC3 sinks current via the associated LED, 47Ω series resistor and optocoupler from the 6V rail.

The worst-case voltage drop across each Darlington at 15mA is 1.0V, for the LED around 2.5V and the optocoupler

The rear panel of the slave unit is pretty spartan, containing only the eight IEC mains output sockets. These are used mainly for their size – they're a lot smaller than standard 3-pin power outlets. You will need to make up (or buy) some IEC-to-3 pin plug adaptors if your power leads aren't terminated in IEC plugs.

1.5V. With a the 6V supply rail at 5.7V (due to regulator tolerances and cable drops), this means that the voltage across each 47Ω resistor will be 0.7V resulting in very close to 15mA through the chain.

It's very unlikely that any particular unit will have all worst-case parts so in reality there is a fair margin for voltage drops across the Cat5 cables. Since the Triacs are only triggered for around 5% of each mains half-cycle, the 100µF bypass capacitors in the slave unit should prevent excessive drops on either rail.

Triac control

When the LED in an optocoupler is turned on, its small internal Triac will conduct bidirectionally. This allows current to flow from the incoming mains active line, through the 470Ω and 360Ω series resistors and then into the connected 40A Triac gate. This will trigger that Triac which will conduct for the remainder of the mains half cycle. Thus, the earlier in the half cycle that the Triac is triggered, the higher the RMS current through the load.

Because the Triacs have a latching action, the trigger current does not need to be provided for very long. Each trigger pulse lasts for around 0.5ms.

The 470Ω resistors and 47nF X2 capacitors at each optocoupler act to limit the rate of change of the voltage across its internal Triac, ie they function as a snubber. This prevents spurious triggering of the internal Triac (and hence the associated 40A Triac) due to mains noise or electromagnetic interference.

Similarly, the 39Ω resistors and 10nF capacitors connected in series across each BTA41 Triac limit the dV/dt rate across the Triac terminals to prevent unintentional triggering from mains supply noise and such. This is especially important when the Triac is driving an inductive load, such as a halogen transformer, as the switch-off spike when the load is disconnected can easily result in the Triac being triggered at the start of the next cycle when it should not be.

The 100µH inductors and 100nF X2 capacitors form an LC filter which limits the inrush current to the load when the associated Triac switches on. This is primarily to prevent magnetic radiation from the mains leads connecting each load, which can be quite severe when applying phase control to loads such as incandescent lamps. This is due to the high inrush currents when the filament is cold.

While each Triac is rated at 40A, the entire slave module is powered from a 10A input socket with appropriate fuse. In addition, other components in the mains power path (such as the inductors) are rated at 5A, so this is the maximum current per output.

There are two reasons why we are using 40A Triacs despite the much lower continuous rating. The first is that when an incandescent lamp is switched on from cold, its filament resistance is a lot lower than when it is at operating temperature. A 230V AC 150W lamp can be expected to have an overall resistance of around 350Ω at full power. It will therefore draw about 230/350 = 657mA RMS. However when the filament is cold, eg when switched on initially, the resistance can be 10% of this or less. This will result in an instantaneous current in excess of 6A and even higher for larger lamps or several in parallel.

Even higher currents can occur when a PAR (parabolic aluminised reflector) light fails. The filament can become disconnected at one end and flail around, possibly shorting against the support wires. In excess of 20A can flow before the stem fuse blows. We don't want to burn out a Triac under this condition so we have made sure that they will survive such an event.

One further point regarding the Triacs: they only latch with a certain minimum current flow. In the case of the BTA41 this is no more than 80mA. This is the reason why we have specified a minimum load of 25W per output. Otherwise, early or late in the mains cycle when the instantaneous mains voltage is relatively low, the Triac may fail to latch, resulting in an incorrect brightness level on that output.

Daisy-chained slaves

The remaining circuitry in the slave module allows for slave daisy-chaining. Up to four slave modules can be connected to a single master module. To ensure that the same length of cable can be run between slave units as can be used between the master and the first slave, we buffer the serial signals using a 74HC04 hex inverter IC (IC4).

The SCLK, LATCH and MASTER CLEAR signals are passed through directly from one slave to the next. Each is inverted twice, in order to buffer the signal but preserve the polarity. As with the master module, there are 100Ω series resistors between the buffer and the output RJ-45 jack.

The serial data stream itself comes from the Q7' output of IC1 and via another 100Ω series resistor. This output from this pin is delayed by eight clocks relative to the serial input.

As a result, when 16 or 32 data bits are shifted through the slave module chain, each serial latch ends up with a different set of eight bits – the first slave latches the first eight, the second slave the second eight, etc. This allows the master to control each slave individually with a single serial sequence.

That's it for this month. Next month we will show you how to build the master and slave modules and explain how the firmware and PC software works. We will also provide a location to download the PC software. SC

PRODUCT SHOWCASE

Wind monitoring with no moving parts!

A new compact wind monitoring system, now available from Amalgamated Instrument Co Pty Ltd, offers an innovative solution to the need to monitor wind conditions.

The system consists of a solid-state wind speed & wind direction transmitter and a compact monitor with displays for both speed and direction and alarm capability to warn of dangerous conditions, such as high wind speed or unacceptable wind direction.

The wind transmitter, with no moving parts, is very compact and rated to IP65. It has NMEA serial output that contains the wind speed & wind direction information.

The panel mount display has a 16-segment circular display for wind direction and a 5-digit display for wind speed. The monitor is equipped with one setpoint relay as standard and up to another three relays can be added as options. The relays can be assigned to either speed or direction as required and are independently configured.

A dual analog retransmission option is also available so that wind speed & wind direction can be retransmitted if required.

Here also, the channels can be independently configured and scaled.

It offers a compact, reliable and accurate method of monitoring and providing warnings where wind speed & wind direction affect operations.

The display can be configured to operate on many supplies including 230VAC, 110VAC, a range of low voltage AC and 12-48VDC (the supply is factory set). The transmitter requires a 12VDC supply.

Contact:
Amalgamated Instrument Co Pty Ltd
Unit 5/28 Leighton Pl, Hornsby NSW 2077
Tel: (02) 9476 2244 **Fax:** (02) 9476 2902
Web: www.aicpl.com.au

Drill through reo with ease . . .

IRWIN tools has introduced a new range of Joran "Speedhammer" POWER drill bits aimed at increasing performance while reducing bit breakages when drilling through reinforced concrete.

Durable and cost-effective, IRWIN's all new Speedhammer POWER range contains two times more carbide for twice as many hits when drilling through reinforced concrete.

When most common SDS drill bits encounter reinforcement bars, they vibrate violently, get locked and ultimately snap off. They can even get so hot that the tip begins to glow, melt and fall out, rendering them useless.

For the tradesman this could mean changing hole positions, drilling at an angle to avoid the bar, or being forced to switch to a metal drill bit; all time-consuming and frustrating options.

With Speedhammer, users can now simply continue to drill through the metal bar, straight and fast. It features premium steel for superior core strength, and its maximised flute design ensures greater dust and debris removal to maintain a cooler carbide tip, extending the lifetime of the bit.

Contact:
Irwin Tools
2 National Dve, Dandenong Sth Vic 3175
Tel: (03) 8787 3888 **Fax:** (03) 8787 380
Web: www.irwin.com.au

One thing to fuel them all: UltraCharge

Australian iPad accessories specialist PADACS today cures one of the great pains of the mobile age – how to keep multiple mobile devices charged with electricty while you're on the move.

PADACS has a portable power supply unit for the iPad, iPhone 4 and 98% of current mobile devices.

Costing $119.95, the PADACS UltraCharge is a 12Ah lithium polymer battery that can charge two mobile devices simultaneously. It can charge notebooks for 2-4 hours; iPhones for 5-6 hours or the iPad for 15-20 hours.

As well as the above devices, the UltraCharge can charge iPods and PSPs plus mobile handsets from Nokia, Sony Ericsson, Motorola, Samsung, LG and HTC.

Weighing just 398g, the PADACS UltraCharge measures 150x80x24mm.

The UltraCharge package contains the mobile accessory charger, a power adapter, a DC output cable, the USB output cable with four adapters and a travel pouch.

The PADACS Ultracharge is distributed by PC Range.

Contact:
PCRANGE
19 Aldenhoven Rd, Lonsdale, SA 5160
Tel: (08) 8186 1800 **Fax:** (08) 8186 0222
Web: www.pcrange.com.au

Spring Clean SALE

Ultrasonic Antifouling System

Refer: Silicon Chip Magazine September/November 2010

Many of you know that you can buy $3-$,000 imported marine growth electronic antifouling systems. Jaycar, with Silicon Chip have developed a similar system based on this technology and information in the public domain. This project uses the same ultrasonic waveforms and virtually identical ultrasonic transducers mounted in sturdy polyurethane housings. By building yourself (which includes some potting) you save a fortune! Standard unit consists of control electronic kit and case, ultrasonic transducer , potting and gluing components and housings. Research reveals only one transducer is needed for boats under 40ft. Basically all parts supplied in the project kit including wiring.

$249.00 including epoxies

- 12VDC
- Suitable for power or sail
- Could be powered by a solar panel/wind generator
- Available end of October - call first for availability

KC-5498

i.Scratch CD & MP3 DJ Station

No need for a laptop or PC - the i.Scratch DJ Station gives you the digital DJ essentials. Front loading CD tray, large LCD screen and an XXL jog wheel. Sample banks, cue point banks, seamless loop & reloop, instant start, auto cue, fast cue, track & folder search, pitch range/bend and scratch. CD, CD-R, CD-RW, MP3 compatible.

- S/PDIF digital audio & RCA coaxial outputs
- Fully programmable repeat function
- Fader start & relay mode
- Measures: 348 (L) x 246(W) x 106(H)mm

AA-0493 WAS $349.00

$299.00 SAVE $50.00

Buy 2 For Only $499

50W Guitar Amplifier

With a nice clean sound, it also has switchable distortion with variable gain and level controls. Notch gain and 1 kHz shape control give you more flexible sound and it also has an effects loop. Good low-cost rehearsal amp for guitar or keyboards.

- 100 - 350Hz notch gain
- Bass and treble controls
- 10" speaker
- Dimensions: 410(W) x 435(H) x 220(D)mm

CS-2556 WAS $199.00

$129.00 SAVE $70.00

NEW REYNELLA STORE

141 Sherriffs Rd Reynella SA 5161

Ph: (08) 8387 3847

Opens early October

200W PA Combo Amp/Speaker

A PA system in a box. 3 channels with balanced and unbalanced inputs, RCA inputs for an auxiliary source. The ideal small PA for schools, sports organisations, churches, weddings and conferences.

- 12" speaker
- 2 channel equaliser
- Line level RCA inputs
- 200WRMS power output
- Dimensions: 600(H) x 410(W) x 325(D)mm

CS-2517 WAS $469.00

Limited Stock

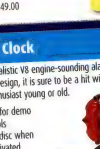
$299.00 SAVE $170.00

Buy 2 For Only $499

100MHz Dual Trace Digital Storage Oscilloscope

Professional level test instrument for the technician, design engineer or development laboratory. Full 100MHz bandwidth to keep up with the current digital chip technology, plus a host of features that make it a cost-effective addition or upgrade to your current test equipment.

Channels: 2
Input impedance: 1Mohm
Bandwidth: 100MHz
Sampling rate: 1GSa/Sec (Per channel)
Max input voltage: 850V P-P, Cat II
Dimensions: 340(W) x 150(H) x 290(D)mm
Accessories: 2 x 10:1 probes, EasyScope software, USB cable
QC-1933 WAS $1,149.00



$999.00 SAVE $150.00

V8 Alarm Clock

Wake up to the realistic V8 engine-sounding alarm. Easy to use and attractive in design, it is sure to be a hit with any motoring enthusiast young or old.

- Realistic pedals for demo and clock controls
- Spinning brake disc when the alarm is activated
- Clock 120mm dia
- Requires 3 x AA Batteries

AR-1769 WAS $29.95

Limited stock

$19.95 SAVE $10.00

Ultrasonic Cleaner Kit

Refer: Silicon Chip Magazine September 2010

Most people would know that you can get small ultrasonic cleaners for jewellery and similar small items, so why not a much larger version? It would be ideal for cleaning automotive and other mechanical parts, fabrics which can't be machine washed, ornate bric-a-brac and a host of other hard-to-clean items. You can use a variety of receptacles for a tank, such as an old cistern or laundry tub. It can also be used with solvents such as kerosene or just water and detergent. The kit includes the transducer, case, cable, electronics and can be powered from a 2.5A 12VDC plugpack. Everything is included in the kit except for a housing for the transducer and sealant. See website for more details.

- Power requirements:12V, 2.5A
- Transducer voltage: 250VAC square wave
- Frequency range: Main mode 19kHz to 42kHz
- Timeout adjustment: 30s to 10m
- PCB and components
- 12VDC

KC-5499

$199.00

USB 3.0 SATA 2.5"/3.5" HDD Dock

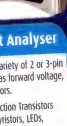
A 2.5"/3.5" SATA dock for USB 3.0 enabled desktop PCs and laptops. USB 3.0 boasts theoretical speeds of up to 4.8Gbps, that's ten times faster than its USB 2.0 predecessor. This dock is particularly useful for computer technicians, IT professionals and those of you who download a lot and need to swap between drives frequently.

- Compatible with Windows XP/Vista/7/Mac 9.X and higher
- Dimensions: 145(L) x 94(W) x 82(H)mm

XC-4696 WAS $79.95

Note: HDD not included

$69.95 SAVE $10.00



Semiconductor Component Analyser

Offers simple identification and testing of a variety of 2 or 3-pin devices. Type and lead identification as well as forward voltage, test current and other parameters for transistors.

- Automatic type identification of Bipolar Junction Transistors (BJTs), Darlington, MOSFETs, JFETs, triacs, thyristors, LEDs, diodes and diode networks
- Automatic pinout identification
- Gain and leakage current measurement for BJTs
- Silicon and germanium detection for BJTs
- Forward voltage and test current
- Dimensions: 100(W) x 71(H) x 27(D)mm

QT-2216 WAS $129.00

$99.00 SAVE $30.00

Colour CCD Wide Angle Waterproof Rear View Camera

A camera designed to assist drivers reversing their vehicles. The tiny camera is easily mounted with the attached mounting bracket and screws. Ideally it should be fixed to an area above your rear licence plate, or any area at the back of the car that will give a good view.

See website for full specs.

- Power supply: 12VDC
- Dimensions: 27(L) x 20(W)mm

QC-3514

$11

www.jaycar.com.au

To order call 1800 022 888

Jaycar Electronics

Better, More Technic

Prices valid until 23/10/2010. Limited stock on sale items. No rainchecks. All Savings are based on Original RRP

Concord HDMI Leads

Feature heavily plated 24K gold plated connectors and extra special oxygen-free heavy copper cabling. Each plug is solidly constructed for frequent, reliable use. Also featured are high quality moulded strain-relief cord grommets.

FROM $34.95

Male to male 500mm	WQ-7906 $34.95
Male to male 1.5m	WQ-7900 $39.95
Male to male 3.0m	WQ-7902 $49.95
Male to male 5.0m	WQ-7904 $59.95
Male to male 10.0m	WQ-7905 $89.95

new

Economy HDMI Leads

new

A cost-effective solution without compromising quality or performance. All have gold plated connectors and are fully HDMI v1.3b and HDCP compliant.

FROM $24.95

1.5m	WV-7915 $24.95
3m	WV-7916 $34.95
5m	WV-7917 $49.95

720p Media Player with USB/SD ports

Media Players are a great way to easily view your collection of downloaded movies or digital pictures on your TV. Once the media player is connected to your TV just attach your USB hard drive or thumb drive with your movies or SD card from your digital camera and start watching. The user interface is as simple as they come with an eye catching design. The remote control gives you complete control over your viewing experience. Extensive file support makes this the perfect home entertainment accessory. Video playback: Supports up to 720p AVI/MP4, DIVX, XVID, Mpeg1/2, RM, RMVB, DAT, MOV (not H.264) and VOB Music playback: MP3, WAV, OGG & WMA audio formats XC-4206

$99.95

new

Also Available:
1080p Media Player with USB/SD/LAN ports
XC-4204 $169.00

Glass Wall-Mount DVD Brackets

Wall mount your DVD player or any other component right under your flat-screen TV. Tempered glass shelves and black anodised aluminium finish to complement modern décor. Also features cable management. Single or double shelf models:

new

Single Shelf	CW-2830 $69.95
Double Shelf	CW-2832 $99.95

FROM $69.95

Outdoor Omni-Directional UHF/VHF Amplified Digital Antenna

new

With inbuilt low noise and high gain booster, this compact and weather resistant outdoor digital antenna is ideally suited for caravans, boats, and other fixed or mobile applications where space is constrained or harsh environmental conditions require a little extra durability. Excellent wide frequency reception for local free-to-air analogue and digital TV, DAB+ digital radio as well as FM radio transmissions. It can be either base mounted or mast mounted; and includes mounting bracket, 12V mains power adaptor, 12V in-car charger and PAL to F coaxial cable.

- SMD technology
- Anti-rust and UV protected
- Receiver dish size: 350(Dia) x 60(H)
- Mounting base size: 120(Dia) x 70(H)

LT-3141

Ideal for Caravans, RV's etc

$89.95

Outdoor Flat Panel UHF/VHF Amplified Digital Antenna

new

A versatile space-saving outdoor antenna that's ideal for apartments and generally when antenna roof mounting is either too difficult or not an option. Once mounted you can easily adjust vertical and tilt position to maximise reception strength. With an integrated amplifier for enhanced reception clarity, it delivers local free-to-air analogue and digital TV as well as DAB+ digital radio programs. It also features weather resistant ABS housing, low noise circuitry, multidirectional 360° reception and auto gain control. Includes mounting bracket, 6V 100mA mains adaptor, and PAL to F coaxial cable.

- Panel size: 281(W) x 305(H) x 20(D)mm

LT-3139

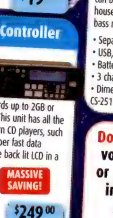
Also available: **Indoor Flat Panel UHF/VHF Amplified Digital Antenna** LT-3131 $49.95

$69.95

Windscreen Mount Suction Bracket for iPhone®

new

A handy device to mount your iPhone® to the windscreen for easy access. The strong 80mm diameter suction mount will keep his iPhone® securely attached. The ball and socket joint enables positioning for maximum effectiveness. Will hold an iPhone® with or without a protective back cover.



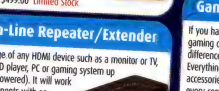
Caution: Always ensure it is mounted so that it does not obstruct your view or cause a distraction.

HS-9004 Note: iPhone® not included

$19.95

Rack Mount Dual MP3 Controller

A revolutionary dual MP3 player that utilises SD storage technology. Each slot accepts SD cards up to 2GB or higher* so you can fit thousands of songs. This unit has all the advanced features found in high end modern CD players, such as full pitch, cue and track controls. With super fast data transfer, track information is displayed in the back lit LCD in a fraction of a second.



- Will support higher capacity SD cards than 2GB, but does not support HD SD.
- Supports ID3 Tag
- 19" 2U standard size
- Power source: 6VDC 1.5A
- Frequency response: 17Hz - 16kHz
- Dimensions: 483(W) x 88(H) x 78(D)mm

AA-0492 WAS $499.00 Limited Stock

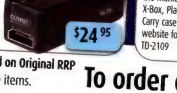
MASSIVE SAVING!

$249.00

SAVE $250.00

HDMI In-Line Repeater/Extender

Extend the range of any HDMI device such as a monitor or TV, set-top box, DVD player, PC or gaming system up to 60 metres (powered). It will work with DVI components with an adaptor. Plugpack included.



- Size: 62 x 22 x 20mm

AC-1698

$24.95

Portable Speaker with Amp & USB

Most PA amps only allow you to plug your mic or guitar in and not much else. This one also has a USB port as well, so you can plug in a memory stick and play MP3 tracks, allowing you to use backing or rhythm tracks in your performance. In addition, you can connect an MP3 player or CD player to the line level inputs via the RCA sockets. It has a built-in rechargeable battery that gives you 3 - 5 hours of use or it can be mains powered. It's housed in a very solid 16mm MDF bass reflex enclosure with 5" coaxial driver.

- Separate volume control on USB channel
- USB, mic & line-in inputs
- Battery or mains powered
- 3 channel mixer
- Dimensions: 245(W) x 280(H) x 245(D)mm

CS-2519 WAS $299.00 Limited Stock

$169.00

MASSIVE SAVING!

SAVE $130.00

Don't forget to use your $10 off voucher on any purchase $100 or over featured after page 426 in your Jaycar Engineering & Scientific 2010 catalogue.

Conditions apply.

Gaming Console Tool Kit

new

If you have ever attempted any repair or improvement on your gaming console, you know that the right tools can make the difference between a good experience and a bad one. Everything you need to get into your gaming console and accessories. Includes tools for pretty much every console and handheld on the market today - Wii, X-Box, Playstation etc. Carry case included. See website for full contents.

TD-2109

$29.95

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

DON'T JUST SIT THERE, BUILD SOMETHING

Spring Clean SALE

ExpressCard with 2 x USB3.0 ports

Achieve transfer speeds of up to 2.5Gbps with this ExpressCard to 2 x USB 3.0 port adaptor for your laptop. Though unable to reach the maximum theoretical speed of USB 3.0 due to ExpressCard bandwidth limitations it is still more than triple the speed of USB2.0 (480Mbps). This is more than enough for a significant reduction in transfer times.

- Compatible with XP, Vista and 7 (32-bit and 64-bit)
- Dimensions: 95(L) x 68(H) x 14(D)mm

XC-4141 WAS $79.95

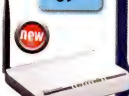
$59.95 SAVE $20.00

802.11n Wireless N Broadband Router with 4 ports

Expand your network with ease, reliability and security. A Wireless-N router with a wireless access point function combined with the flexibility of a 4-port switch, and a built-in firewall. Setup is streamlined through the configuration wizard where you can change dozens of settings.

- Setup Wizard for easy configuration
- Provides up to 3 times the transmission rate and double the range of 802.11g products
- Supports UPnP and DDNS
- Meets 64/128-bit WEP, WPA, and WPA2 security standards
- Detachable antenna

YN-8305



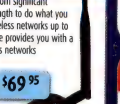
$69.95

High Power Wireless N USB 2.0 Network Adaptor

Able to reach wireless networks from significant distances with enough signal strength to do what you need. The unit can connect to wireless networks up to 1.5km away. The supplied software provides you with a myriad of specifications of wireless networks broadcasting in your area.

- Dimensions:75(L) x 58(W) x 10(H)mm
- Antenna: 172(H)mm

YN-8306



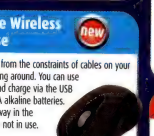
$69.95

Rechargeable Wireless Optical Mouse

Enjoy complete freedom from the constraints of cables on your workstation when mousing around. You can use rechargeable batteries and charge via the USB lead or simply use 2 x AA alkaline batteries. The USB dongle stores away in the mouse's back door when not in use.

- Plug and play
- Windows 2000, XP, Vista, 7

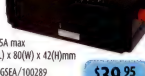
XM-5246



$29.95

Switchmode Mains Adaptor 3 - 13.8VDC 2.5A

Variable desktop power supply with binding post and 7 DC plugs. 1.5 metre lead with interchangeable connectors.



- Output voltage: 3, 5, 6, 9, 12, 13,8VDC
- Output current: 2.5A max
- Dimensions: 140(L) x 80(W) x 42(H)mm

Approval number: SGSEA/100289

MP-3308

$39.95

2.5" SATA HDD Enclosure - USB 3.0

Take advantage of the massive speed increase of USB 3.0. Slot a 2.5" SATA HDD into this enclosure and when connected to a USB 3.0 port of a computer you will experience speeds up to 10 times faster than USB 2.0.

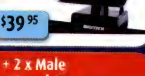
- Includes one 1.1m USB 3.0 Micro B - to Male A cable
- Locking screws included
- Dimensions: 77(W) x 113(L) x 14(D)mm

XC-4684 WAS $59.95

$49.95 SAVE $10.00

Web Camera with Microphone

Ideal for podcasting or creating a YouTube masterpiece. No drivers required, just plug and shoot. Built-in microphone included for adding sound.



- 2MP
- Plug-and-play

QC-3233

$39.95

2 x e-Sata + 2 x Male Molex Front Panel

Leave USB 2.0 in the dust and add this front panel to your PC for the convenience of 2 eSATA ports and 2 male molex plugs. ESATA gives speeds that are up to 6 times faster than USB 2.0 so there's no reason to use your external hard drives on a USB 2.0 port anymore.

- Dimensions: 11(W) x 25(H) x 97(D)

XC-4699 WAS $19.95

$14.95 SAVE $5.00

4-Port USB 3.0 Hub

USB 3.0 hub with four ports. 4.8Gbps data rate. 10 x faster than USB 2.0.

- Dimensions: 85(L) x 32(W) x 18(H)mm

XC-4947 WAS $79.95

$69.95 SAVE $10.00

USB 3.0 to 2.5/3.5" HDD/SSD SATA Adaptor

Collected a box full of hard drives over the years? Want a simple way to access them? This adaptor is the perfect tool. Older USB 2.0 SATA adaptors are unable to extract the full 3.0Gpbs transfer speed of SATA drives, so you're restricted to a paltry 480Mpbs. This adaptor will give you the speed you need to transfer large file in a fraction of the time (your PC must have a USB 3.0 port).

- Compatible with Windows 2000/XP/Vista/Win 7/MAC OS 9.X/10.X/Linux
- Dimensions: 70(L) x 39(W) x 11(D)mm

XC-4145 WAS $79.95

$59.95 SAVE $20.00

Line Interactive UPS - 600VA

Compact and completely self-contained, this is the ideal backup solution for your data or other important equipment. It has 3 surge-protected outlets as well as 3 outlets backed up by the UPS. It also has RJ11 ports for protecting phone or fax lines.

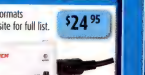
- Cold start feature
- Software included
- Rating: 375W, 600VA
- SLA battery: 7Ah
- Supply voltage 220 to 280VAC
- Backup time: 3 min at full load
- Recharge time: 10 hrs
- Output waveform: Step sine wave
- Dimensions: 268(L) x 180(W) x 80(H)mm

MP-5222

$119.00

USB 5-Button Laser Mouse

All the normal mouse functions - left and right click, scrolling, plus forward, back and quick-launch button. Ergonomically shaped for fatigue-free use.



- Plug and play - no drivers required
- Windows 2000, XP, Vista, 7

XM-5240

$17.95

All-In-One Card Reader

Supports SD, MMC, MS and CF formats including Micro-drive. See website for full list.

- Plug and play
- USB 2.0
- Dimensions: 60(L) x 40(W) x 13(H)mm

XC-4849

$24.95

www.jaycar.com.au

Limited stock on sale items.

All Savings are based on Original RRP

Jaycar Electronics

Better. More Technical

Spring Clearance Sale

Buy NOW Save $$$ Over 10 to 80% OFF ALL listed Items

Listed below are a number of discontinued (but still good) items that we can no longer afford to hold in stock. We need more space in our stores! You can get most of these items from your local store but we cannot guarantee this. Please ring your local store to check stock. At these prices we won't be able to ship from store to store.
Items will sell fast and stock is LIMITED. ACT now to avoid disappointment. Sorry NO rainchecks!

Audio/Video Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
AV Wireless Receiver 2.4GHz & Remote Control for AR-1886	AR-1847	$59.95	$24.00	$35.95
AV Wireless Sender & Receiver - 2.4Ghz	AR-1836	$76.95	$40.00	$36.95
Bluetooth Transmitter Rechargeable - Suits iPod®	AR-1859	$69.95	$24.00	$45.95
Cassette Player/Recorder with USB & Audio Output	GE-4052	$79.95	$39.00	$40.95
FM Transmitter for USB/SD, MP3/PMG4	AR-1867	$109.00	$44.00	$65.00
FM Transmitter Stereo Bluetooth Adaptor	AR-1854	$69.95	$30.00	$39.95
Guitar/USB Interface Adaptor	AM-2037	$119.00	$45.00	$74.00
HDMI Extender over Cat 5/6 with PSU	AC-1699	$139.00	$55.00	$84.00
Headphone Wireless 2.4GHz Digital and Transmitter	AA-2035	$99.95	$62.00	$37.00
Headphones - 12dB Noise Cancelling	AA-2058	$99.95	$43.00	$56.75
Lead - AV 2 x RCA / 1 x S-Video to SCART - 1.5m	WQ-7246	$34.95	$7.95	$27.00
Lead - AV Plug-to-Plug 2 x RCA / 1 x S-Video - 1.5m	WQ-7254	$34.95	$7.00	$27.95
Lead - AV SCART Plug to 6 x RCA Plugs - 1.5m	WQ-7243	$34.95	$13.00	$21.95
Lead - AV SCART Plug to 6 x RCA RGB Plugs - 1.5m	WQ-7243	$49.95	$18.00	$31.95
Lead - AV SCART to 2 x RCA / 1 x S-Video - 1.5m	WQ-7247	$34.95	$9.00	$25.95
Lead - AV S-Video 4 Pin Plug to 2 x RCA plug - 1.5m	WQ-7218	$23.95	$6.00	$17.95
Lead - S-Video & 2 x RCA plugs to S-Video & 2 x RCA Plugs - 3m	WQ-7256	$49.95	$16.00	$33.95
Microphone Audio Adaptor - 6.5mm Plug to USB	AM-2036	$29.95	$14.00	$15.95
PA AMP 2 X 160WMS Rack Mount 240VAC	AA-0478	$289.00	$144.00	$145.00
Party DJ MIDI Controller/Mixer - 2 Channels w/Software	AM-4250	$349.00	$159.00	$190.00
Party Lighting - 20W Black Light Fluoro Tube 2ft 240VAC	SJ-3151	$17.95	$3.50	$14.45
Party Lighting - 26W Red Fluo Tube Bayonet 3U 240VAC	SJ-3153	$22.95	$10.00	$12.95
Party Lighting - PAR36 Pin Can Light with Colour Wheel and Motor- 240VAC	SJ-2963	$49.95	$24.00	$25.95
Plasma TV Wall Bracket with Swivel Mount 80kg	CW-2824	$179.00	$90.00	$89.00
RCA to Toslink Converter 60Cm	AA-1722	$39.95	$20.00	$19.95
Speaker - Crossover 3 Way 40WRMS 5kHz	CR-2615	$16.50	$5.00	$11.50
Speaker - Crossover PCB 3 Way 12dB/Octave	CR-2606	$17.50	$5.00	$12.50
Speaker - Stands (Pair) with Glass Base	CW-2843	$69.95	$30.00	$39.95
Speaker 2.1 Surround Sound System with Amp	CS-2466	$199.00	$79.00	$120.00
Speaker Hi-Fi - In-Wall 8" 100WRMS Subwoofer	CS-2447	$49.95	$17.00	$32.95
Speaker Hi-Fi - High-End 5" 60WRMS Kevlar Cone Driver	CW-2152	$89.95	$36.00	$53.95
Speaker Hi-Fi - High-End 8" 150WRMS Kevlar Cone Woofer	CW-2156	$159.00	$71.00	$88.00
Speaker Hi-Fi - High-End 10" 150WRMS Kevlar Woofer	CW-2158	$179.00	$71.00	$108.00
Speaker Marine - 2 Way 4" - Response Precision	CS-2390	$44.95	$14.00	$30.95
Speaker Marine - 2 Way 6.5" - Response Precision	CS-2392	$54.95	$22.00	$32.95
Speaker Stands PA Aluminium	CW-2862	$99.00	$49.00	$50.00
Speaker Stereo - Active Tower 500WRMS with Remote 240VAC	AR-1897	$169.00	$79.00	$90.00
Stereo Earphones with Radio	AA-2062	$19.95	$10.00	$9.95
Stylus Replacement for GE-4063	GE-4069	$24.95	$5.00	$19.95
TV Antenna - Wall Brackets to Clear Eaves - 280mm	LT-3210	$14.95	$6.00	$8.95
TV Lightning Protector 2.4GHz N Male to Female	AR-3278	$89.95	$27.00	$62.95
USB Microphone with Stand	AM-4102	$99.95	$50.00	$49.95
USB to XLR Mic Adaptor- Cable	AM-2038	$29.95	$14.00	$15.95

IT & Comms Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Antenna - 2.4GHz WiFi 10DB Gain - Wall Mount Panel	AR-3275	$89.95	$29.00	$60.95
Antenna - 2.4GHz WiFi 3dB Gain - Ceiling Mount	AR-3271	$49.95	$15.00	$34.95
Antenna - 3.5GHz WiFi 12dB Gain - Wall Mount Panel	AR-3274	$119.95	$47.00	$72.95
Bluetooth GPS Receiver	AC-4895	$149.00	$53.00	$96.00
Book - Easy PC Case Modding	BB-7096	$29.95	$11.00	$18.95
Book - Easy PC Keyboard Shortcuts Book	BB-7092	$29.95	$11.00	$18.95
Book - Gardening with Computers for the Older Generation	BB-7068	$29.95	$11.00	$18.95
Book - Getting More From Xbox 360	BB-7094	$34.95	$11.00	$23.95
Book - Internet Banking/Shopping for the Older Generation	BB-7069	$29.95	$11.00	$18.95
Book - Using Vista Media Centre Microsoft	BB-7108	$29.95	$11.00	$18.95
Book - Vista for the Older Generation	BB-7111	$29.95	$11.00	$18.95
Book - Vista Upgrading & Troubleshooting	BB-7107	$29.95	$11.00	$18.95
Book - Windows Vista Explained	BB-7103	$29.95	$11.00	$18.95
Book - Windows Vista for Beginners	BB-7113	$29.95	$11.00	$18.95
Electronic Photo Frame Digital 7" Slimline Design	QM-3777	$99.00	$58.00	$41.00
Electronic Photo Frame Digital 1.5" with Clock & Calendar	QM-3778	$39.95	$18.00	$21.95
Electronic Photo Frame Digital 10.4" - Bluetooth Enabled	QM-3767	$349.00	$159.00	$190.00
Fan for CPU Ventilation 80mm - Blue	XC-9028	$19.95	$6.00	$13.95
Hub - Combo USB Hub/Radio/MP3 Player	XC-4844	$19.95	$7.00	$12.95
Labelling Kit for CD/DVD	XC-4920	$14.95	$3.50	$11.45
Laser Pointer Green 1mW Keyring	SY-3119	$69.95	$28.00	$41.95
Mouse - Combo USB Optical Mouse & Skype Phone	XM-5136	$59.95	$18.00	$41.95

Product Description	Cat No	Original RRP $	Special Price $	Save $
PCI Card - 3 Port IEEE1394 Firewire	XC-4818	$35.00	$17.00	$18.00
PCI Interface Card - 2 Port SATA Controller with RAID	XC-4868	$49.95	$18.00	$31.95
PCI Interface Card - 4 Port SATA Controller with RAID	XC-4869	$69.95	$25.00	$44.95
PSP High Capacity Clip-On Battery Pack	XC-5198	$119.95	$36.00	$83.95
PSP UMD Disc Cleaner	XC-5196	$24.95	$8.00	$16.95
Speaker Active 2-way for PC/MP3/iPod with PSU	XC-5182	$45.00	$25.00	$20.00
Speaker Active for MP3 Player with Tripod	XC-5159	$49.95	$17.00	$32.95
Speaker for PC with USB MP3 Flash Player	XC-5161	$89.95	$34.00	$55.95
Storage - USB OTG Data Storage Bridge	XC-4962	$59.95	$18.00	$41.95

Outdoors & Automotive Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
24VDC Portable Jaffle Iron	YS-2806	$39.95	$14.00	$25.95
240VDC Portable Kettle	YS-2809	$24.95	$5.00	$19.95
24VDC Portable Stove	YS-2807	$49.95	$18.00	$31.95
Amplifier Car - 2 x 150WRMS Precision Response	AA-0424	$219.00	$99.00	$120.00
Battery Charger - 4 x AAA Ni-MH to suit DC-1010	DC-1014	$14.95	$2.95	$12.00
BBQ Cleaning Brush with Inbuilt LED	YS-2542	$29.95	$7.00	$22.95
Camera Clip-On CCD Reversing with Lead -12VDC	QC-3729	$249.00	$119.00	$130.00
Car - In-Dash 7" LCD with Remote - 12VDC	QM-3782	$269.00	$99.00	$170.00
Car Alarm - 2 Way Paging with Rechargeable Remote	LA-9018	$329.00	$159.00	$170.00
Car Charger 4 x AAA Ni-MH to suit DC-1010	DC-1016	$14.95	$2.95	$12.00
Car Power Window Closer - 2 Door	LR-8851	$59.95	$22.00	$37.95
Car Power Window Closer - 4 Door	LR-8853	$69.95	$29.00	$40.95
Digital Pen Notetaker	QC-0355	$179.00	$79.00	$100.00
Electronic Tick Remover	YS-5538	$24.95	$4.00	$20.95
Fishing Tool Set with Scale, Torch & Plier	YH-2053	$29.95	$9.00	$20.95
FM Stereo Transmitter - Suits iPod®	AR-3112	$39.95	$12.00	$27.95
LCD Monitor with 7" Bluetooth Rear Vision Mirror	QM-3763	$299.00	$149.00	$150.00
Light - Rechargeable LED Outdoor Umbrella Light	ST-3292	$24.95	$9.00	$15.95
Light - Remote Controlled with Magnetic Base	ST-3182	$24.95	$8.00	$16.95
Light - Wireless Brake for Motorcycle Helmets	ST-3186	$49.95	$16.00	$33.95
Lighting - Solar Waterproof Electronic Candles 5 Pack	ST-3928	$39.95	$14.00	$25.95
Rain Gauge Digital Wireless with Anemometer	XC-0338	$99.95	$40.00	$59.95
Spare Li-Ion Battery to suit DC-1014	DC-1095	$39.95	$10.00	$29.95
Speaker - 10" Subwoofer - Response Precision	CS-2352	$219.00	$79.00	$140.00
Speaker - Car 6" Venom Splits with Silk Tweeter	CS-2389	$89.95	$25.00	$64.95
Speaker - Car Ribbon Tweeter with Crossover & Mounts	CS-2339	$89.95	$44.00	$45.95
Speaker - Rubber Surround Kit - 12"	CF-2793	$39.95	$8.00	$31.95
Torch - 2 in 1 Dynamo LED with Screwdriver Set	ST-3350	$24.95	$11.00	$13.95
Torch - Dynamo 5-in-1 Power Bank with Radio & Siren	ST-3370	$59.95	$23.00	$36.95
Weather Station - Spare Wireless Temp Transmitter for XC-0338	XC-0334	$29.95	$5.00	$24.95
Weather Station - Spare Wireless Temp Transmitter for XC-0339	XC-0337	$29.95	$8.00	$21.95
Weather Station with Wireless Sensors and Doorbell	XC-0336	$99.95	$34.00	$65.95

Power Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Battery - 7.4V 3300mAH Lithium-Polymer Pack	SB-2310	$118.00	$58.00	$60.00
Battery - 70 Amp Dual Battery Power Selector	MB-3672	$99.95	$44.00	$55.95
Battery - Li-Po 3.7V 1600mAh for iPod® 1st & 2nd Gen	SB-2570	$23.95	$9.00	$14.95
Battery - Li-Po 3.7V 2500mAh for iPod® Shuffle 1st Gen	SB-2578	$22.95	$7.00	$15.95
Battery - Ni-Cd 3.6V 300mAh for Telephones	SB-2471	$16.95	$5.00	$11.95
Battery - Ni-MH PC Backup 3.6V 40mAh - Varta	SB-1606	$14.95	$5.00	$9.95
LED RGB Controllers with Remote Control - 12/24VDC	MP-3271	$69.95	$34.00	$35.95
Lighting - Mains Dimmer with Panel 240V 400VA	PS-4082	$29.95	$13.00	$16.95
Plugpack Switchmode - 6VDC 1.66A 2.5mm Plug	MP-3232	$23.95	$9.00	$14.95
Plugpack Switchmode - 24VDC 100W 0/Frame	MP-3122	$95.00	$42.00	$53.00
Plugpack Switchmode - 5VDC/6A 24VDC/4A 120W 0/Frame	MP-3123	$119.00	$48.00	$71.00
PSU for Luxeon LED - 1 x 3W 3.5VDC 800mA	MP-3274	$19.95	$9.00	$10.95
PSU for Luxeon LED - 3x 1W 10VDC 350mA	MP-3270	$19.95	$9.00	$10.95
PSU for Luxeon LED - 6 x 3W 22VDC 700mA	MP-3278	$33.95	$7.00	$26.95
RF Remote Controlled Receiver 240V for MS-6134	MS-6138	$29.95	$13.00	$16.95
Transformer 240VAC - 15-30V 2A 60VA Multi-Tapped	MM-2009	$27.95	$14.00	$13.95
Transformer Toroidal 12-0-12 75VA	MP-2040	$24.95	$9.00	$15.95
Transformer Toroidal 6-0-6 3.2VA	MP-2030	$21.95	$9.00	$12.95
Transformer Toroidal 6-0-6 7VA	MP-2036	$24.95	$9.00	$15.95
Transformer Toroidal 9-0-9 7VA	MP-2038	$24.95	$9.00	$15.95
Wind Generator - 300W 24VDC	MG-4532	$599.00	$449.00	$150.00

Be sure to check out the full range of clearance lines in-store or on the Web. Many items only have one or two units in a couple of stores and you can get a fantastic bargain if you ask.
^Off Original RRP. Limited stock, no rainchecks, may not be available at all stores - call your local store to check stock details. Valid till 23rd October 2010 or while stocks last!

Better, More Technical

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To order call 1800 022 888

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Security & Surveillance Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Alarm - 4 Zone Wireless Kit	LA-5134	$89.95	$44.00	$45.95
Alarm - 8 Zone 2 Wire Kit	LA-5477	$149.00	$89.00	$60.00
Alarm - Spare Receiver 2 Wire Kit for LA-5477	LA-5478	$29.95	$17.00	$12.95
Alarm - Economy 6 Zone Wireless Alarm System	LA-5135	$169.00	$89.00	$80.00
Alarm - Wireless Sensor Reed Switch to suit LA-5135	LA-5137	$34.95	$16.00	$18.95
Alarm - Wireless Remote Control to suit LA-5135	LA-5138	$24.95	$14.00	$10.95
Alarm - Wireless Sensor Reed Switch to suit LA-5125	LA-5128	$34.95	$16.00	$18.95
Alarm - Wireless PIR Converter Kit with Remote	LA-5050	$149.00	$69.00	$80.00
Alarm - Wireless PIR to suit LA-5050	LA-5051	$49.95	$24.00	$25.95
Alarm - Wireless Reed Switch to suit LA-5050	LA-5052	$39.95	$14.00	$25.95
Alarm - Wireless RF Remote Control to suit LA-5050	LA-5053	$29.95	$10.00	$19.95
Balun - Component Video CAT5	QA-3682	$44.95	$15.00	$29.95
Balun - RGB CAT-5 Video	QC-3429	$27.95	$15.00	$12.95
Balun - S-Video CAT-5	QC-3423	$49.95	$17.00	$32.95
Balun - Video/Audio Cat-5 With BNC-RCA Adaptor	QC-3424	$46.95	$27.00	$68.00
Camera - 2.4GHz CMOS Colour with Sound	QC-3595	$169.00	$65.00	$104.00
Camera - 2.4GHz CMOS Day/Night to Suit QC-3626	QC-3626	$299.00	$94.00	$205.00
Camera - 2.4GHz CMOS Pro-Tilt Night Vision with Portable LCD	QC-3579	$399.00	$179.00	$220.00
Camera - 2.4GHz Colour CMOS Camera/Receiver System with IR	QC-3584	$229.00	$99.00	$130.00
Camera - 2.4GHz Transmitter with BNC Connection	QC-3594	$69.95	$28.00	$41.95
Camera - 2.4GHz Wireless Modules	QC-3258	$169.00	$79.00	$90.00
Camera - 2.4GHz Wireless Modules - Transmitter	QC-3598	$19.95	$9.00	$10.95
Camera - 3.5GHz Outdoor Colour CMOS Day/Night	QC-3575	$169.00	$65.00	$104.00
Camera - CCD B&W Dummy 380TVL	QC-3472	$89.95	$28.00	$61.95
Camera - CCD B&W Outdoor (IP57) IR 30NOT	QC-3490	$169.00	$65.00	$104.00
Camera - CCD Colour Dome 480TVL Pan/Tilt/Zoom	QC-3500	$499.00	$199.00	$300.00
Camera - CCD Colour Dome 550TVL with IR	QC-8600	$299.00	$119.00	$180.00
Camera - CMOS Colour Flush Mount- Weatherproof	QC-3452	$169.00	$59.00	$110.00
Camera - CMOS Gooseneck Colour Inspection	QC-3389	$199.00	$75.00	$124.00
Camera - CMOS IR Bullet with Lead	QC-3096	$99.00	$35.00	$64.00
Camera - Colour CCD Dome 350TVL with Sony Sensor	QC-3318	$179.00	$79.00	$100.00
Camera - Colour Mini Dome Sharp Sensor	QC-3087	$149.00	$64.00	$85.00
Camera - Housing ABS Outdoor	QC-3385	$59.95	$25.00	$34.95
Camera - IP MPEG4 Cam with 6 x IR LEDs	QC-3396	$249.00	$99.00	$150.00
Camera - IP MPEG4 Cam with 6 x IR LEDs - Wireless	QC-3398	$349.00	$139.00	$210.00
Camera - Pro CCD B&W 380TVL Day/Night	QC-3310	$109.00	$45.00	$64.00
Camera - Pro CCD B&W 480TVL Day/Night	QC-3300	$199.00	$89.00	$110.00
Camera - Pro CCD Colour 380TVL Day/Night 35m Range	QC-3378	$399.00	$169.00	$230.00
Camera - Pro CCD Colour 480TVL - 50m IR - Sony Super HAD CCD Sensor	QC-3381	$549.00	$299.00	$250.00
Camera - Pro Housing 3'R LEDs, Fan and Heater - 24V	QC-3386	$99.95	$39.00	$60.95
Camera - Spare 2.4GHz for QC-3258	QC-3259	$99.95	$65.00	$34.95
Camera -Dummy with Corner Mount Bracket - Beige	QC-3512	$29.95	$9.00	$20.95
DVR - Mobile 250GB Portable 4 Channel 12-24VDC	QV-3093	$1,399.00	$629.00	$770.00
Monitor Security - 19" Active matrix TFT	QM-3420	$549.00	$249.00	$300.00
Quad Processor & 2 IR Colour Camera Kit with PSU & Leads	QV-3095	$349.00	$139.00	$210.00
Receiver - Pan Tilt Zoom Control - IP65 with PSU	QC-3214	$189.95	$69.00	$120.95
Receiver - Pan Tilt Zoom Controller with PSU	QC-3212	$149.95	$69.00	$80.95
RFID Keypad Access Controller	QA-5123	$169.00	$59.00	$110.00
RFID Proximity Access Control Kit with 5 Cards	LA-5120	$225.00	$99.00	$126.00
Safe for Keys - Push Button Lock with Rubber cover	LA-5327	$59.95	$29.00	$30.95
Siren/Strobe Bellbox Polycarbonate	LA-5305	$49.95	$29.00	$20.95
Siren/Strobe Wireless with Solar Charger	LA-5307	$249.00	$89.00	$110.00
Transmitter - Long Range Video 1.5km	QC-3425	$179.00	$89.00	$90.00

Test Equipment, Tools, Soldering and Electronic Component

Product Description	Cat No	Original RRP $	Special Price $	Save $
Book - 308 Circuits	BM-2472	$34.95	$16.00	$18.95
Bungee Cords Assorted - 25pcs	HP-0636	$19.95	$9.00	$10.95
Cable - 3m Hi-Fi Stand Alarm Core	WB-1593	$24.00	$9.00	$15.00
Capacitor - SMD Tantalum 4U7 35V 10 Pack	R2-6532	$19.95	$7.00	$12.95
Connector - Plug XLR 5 Pin Male Amphenol Mount - Silver	PP-1072	$17.95	$5.00	$12.95
Connector - Socket XLR 4 Pin Female Amphenol Mount (Lock)	PS-1046	$16.95	$5.50	$11.45
Connector - Socket XLR 5 Pin Female Amphenol Mount (Lock)	PS-1076	$24.95	$7.00	$17.95
Connector - Socket XLR 5 Pin Female Amphenol Plug	PS-1074	$18.95	$6.50	$12.45
Display Panel - 12 Year Character Backlit LCD	QP-5519	$29.95	$9.00	$20.95
Fuel Cell - Proton Exchange Membrane (PEM) - 600mW	ZM-9082	$149.95	$44.00	$105.95
Fuel Cell - Proton Exchange Membrane (PEM) - 300mW	ZM-9080	$99.00	$37.00	$62.00
Geardox /Abrasive - Worm Drive	WP-2743	$29.95	$10.00	$19.95
Globe Neon - NE-2 90 Volt with 150k Resistor - 100 pack	SL-2689	$22.50	$4.00	$18.50
IC - Command Control Decoder ZN409CE	ZK-8827	$28.00	$9.00	$19.00
Junction Box with Mounting Diodes for Solar Installs- IP65	ZM-9090	$39.95	$18.00	$21.95
Laser Level with Tape Measure	ST-3113	$39.95	$9.00	$30.95
Lead - ATA133 IDE Internal Cable 450mm Black	PL-0970	$21.95	$5.00	$16.95
Lead - ATA133 IDE Internal Cable 900mm Black	PL-0974	$35.00	$8.00	$27.00
Lead - USB BUS Power - 2xUSB-A to USB-B - 1.3m	WC-7750	$18.95	$5.00	$13.95
LED - 12VDC SMD LED Light Strips - Pink	ZD-0464	$54.95	$18.00	$36.95
LED - 1W Luxeon Star Module Green	ZD-0402	$16.95	$10.00	$6.95
LED - 1W Luxeon Star Module White	ZD-0404	$16.95	$10.00	$6.95
LED - 1W Super Bright Star Module - Warm White	ZD-0510	$12.95	$5.00	$7.95
LED - 1W Luxeon Star Module Amber	ZD-0434	$29.95	$14.00	$15.95
LED - 1W Luxeon Star Module Blue	ZD-0438	$29.95	$14.00	$15.95
LED - 1W Luxeon Star Module Green	ZD-0436	$29.95	$14.00	$15.95
LED - 1W Luxeon Star Module Red	ZD-0432	$29.95	$14.00	$15.95
LED - 3W Luxeon Star Module White	ZD-0430	$29.95	$14.00	$15.95
LED - 3W Luxeon Star Module White Side Emitter	ZD-0439	$29.95	$14.00	$15.95
LED - 3W Super Bright Star Module - Blue	ZD-0526	$19.95	$10.00	$9.95
LED - 3W Super Bright Star Module - Red	ZD-0520	$19.95	$10.00	$9.95
LED - 3W Super Bright Star Module - Warm White	ZD-0530	$19.95	$8.00	$11.95
LED - 3W Super Bright Star Module - White	ZD-0528	$19.95	$10.00	$9.95
LED - Festoon Light globe 12VDC 13mm	ZD-0482	$14.95	$7.00	$7.95
LED - Festoon Light globe 12VDC 41mm	ZD-0482	$19.95	$7.00	$12.95
LED - Pink SMD 0603 1c Suit Nokia - 6 Pack	ZD-2022	$24.95	$4.95	$20.00
Lighting - 12V Bayonet LED Globe 6 x White	ZD-0302	$24.95	$5.50	$19.45
Lighting - 12V Mini Edison LED Globe 6 x White	ZD-0300	$24.95	$5.50	$19.45
Lighting - 12V MR16 LED Spot Lamp 20 x Blue	ZD-0321	$29.95	$7.00	$22.95
Lighting - 12V MR16 LED Spot Lamp 20 x Red	ZD-0323	$24.95	$7.00	$17.95
Lighting - 12V MR16 LED Spot Lamp 20 x Yellow	ZD-0324	$24.95	$9.00	$15.95
Magnetic Wrist Tray with 6 Power Bits	HH-1971	$34.95	$14.50	$20.45
Module - Master/Slave M119	AA-0230	$19.95	$9.00	$10.95
Module - RFID Access Control with Tag	AA-0210	$69.95	$34.00	$35.95
Module - RFID Tag 128Mx1 (M131) to Suit AA-0210	AA-0211	$16.95	$7.00	$9.95
Motor - High Speed Gearbox/Motor Set - Tamiya	YG-2746	$29.95	$13.00	$16.95
Ratchet Set - 23 Piece	ZD-0029	$34.95	$11.00	$23.95
Resistor Kit - Surface Mount 72 Values 50 Pieces ea	RK-2660	$49.95	$24.00	$25.95
Screwdriver 6 in 1 set	TD-2028	$18.95	$9.00	$9.95
Single Stage Classic Style Universal Joint (Female) 6mm	WC-1606	$34.95	$14.00	$20.95
Soldering - Desoldier Braid Refill to suit NS-3040/42	NS-3043	$19.95	$6.00	$13.95
Soldering - Spare 20mm Tip to Suit T-1700 - 2 Pack	TS-1704	$24.95	$6.95	$18.00
Soldering - Spare 2mm Tip to Suit T-1700 - 2 Pack	TS-1701	$24.95	$6.95	$18.00
Soldering - Spare 5mm Tip to Suit TS-1700 - 2 pack	TS-1702	$24.95	$7.00	$17.95
Switch - 17V Illuminated SPDT - Momentary	SP-0753	$19.95	$19.00	$10.95
Temperature / Soil Moisture Sensor for QM-7206	QM-7207	$17.95	$1.00	$16.95
Tester - Battery/ Charger/ Alternator 24VDC	QP-2259	$12.95	$4.50	$8.45
Tester - Meter RS-232	QP-0886	$39.95	$19.95	$16.45
Tester - Universal LCD Battery Checker with Capacity Test	QP-2255	$59.95	$39.00	$20.95
Tester - VHF Multimode Low Voltage Cable	QP-2296	$99.00	$89.00	$10.00
Wafer Card - Silver PIC16F877+24LC64	ZZ-8810	$19.95	$9.00	$10.95
Wall Plate with 2 x HDMI Skts - White	PS-0286	$29.95	$14.00	$15.95
Wall Plate with HDMI Skt - White	PS-0285	$19.95	$11.00	$8.95

General Consumer Products

Product Description	Cat No	Original RRP $	Special Price $	Save $
Air Pump Inflator/Deflator 240V	GH-1111	$24.95	$10.00	$14.95
Bird Feeder with AM/FM Radio and LED Torch	GC-2308	$34.95	$14.00	$20.95
BBQ Thermometer & LCD Display	GH-1923	$34.95	$14.00	$20.95
BBQ Tongs with LED Light - Stainless Steel	GG-2309	$14.95	$4.50	$10.45
Body Fat Scales with LCD	MH-7253	$19.95	$5.00	$14.95
Clock Alarm - LCD with Projector & Temperature	QC-9218	$24.95	$9.00	$15.95
Clock Alarm - LED Sunrise Simulation	AR-1787	$79.95	$18.00	$61.95
Clock Alarm - Military Helicopter	AR-1766	$24.95	$7.00	$20.00
Clock Alarm - Shocking Novelty (2 x AAA)	GH-1109	$19.95	$7.50	$12.45
Clock Alarm - Water Powered (Large)	AR-1781	$39.95	$15.00	$24.95
Clock LED Blue Digital with Temperature & Remote	AR-1796	$149.00	$99.00	$50.00
Colour Changing Cube with Timer & PSU	GH-1814	$49.95	$18.00	$31.95
Digital Medical Microscope Handheld Viz Zoom with Image Capture	QC-3246	$249.00	$110.00	$139.00
Digital Video Camera - 5MP PVR with 2" LCD	QC-3236	$99.00	$74.00	$25.00
Electronic Handheld Sudoku Game	GH-1470	$19.95	$8.15	$10.95
Gulfing Green Novelty Ashtray	GH-1886	$24.95	$9.00	$15.95
Kit - 4 Kids Music	KJ-8816	$19.95	$5.00	$14.95
Kit - Human body	KJ-8828	$19.95	$7.00	$12.95
Kit - Nature Mysteries	KJ-8826	$29.95	$8.00	$21.95
Kit - Time Capsule LED Digital Clock	KJ-8910	$34.95	$9.00	$25.95
Lighting - LED Desklamp with Pivot Head	GY-3129	$24.95	$10.00	$15.00
Massager - Neck with 8 Nature Sounds	GH-1757	$39.95	$19.00	$20.95
Mirror - Antilog Travel with Clock & Alarm	GH-1512	$19.95	$9.00	$10.95
Novelty Bingo Game Caller	GH-3742	$49.95	$9.00	$40.00
Pen - 4 in 1 with PDA Stylus, Torch, Laser Pointer	ST-3101	$23.95	$10.00	$13.95
Pencil Vacuum Cleaner - Rechargeable Long-Reach	GH-1392	$39.95	$14.00	$25.95
Pet Leash - Illuminated with Blue LED	GH-1204	$19.95	$5.00	$14.95
Pill Box Reminder with Alarm and Pulse Meter	GG-2002	$19.95	$9.95	$10.95
Pink BBQ Tool Set	GH-2307	$24.95	$12.95	$12.95
Pink Novelty Spider Catcher (4 x AA)	GH-1870	$14.95	$4.50	$10.45
Prenatal Heart Listening Device with Speakers	GH-1870	$49.95	$19.00	$30.95
Sanitiser - Negative Ion Shoe Odour Eliminator	GH-1194	$29.95	$18.00	$11.95
Sanitizer - Personal Ozone/Ion (6 x AA)	GH-1192	$39.95	$13.00	$28.95
Sealer - Vacuum with 3 Bags	GH-1342	$24.95	$12.00	$12.95
Stapler - White/Silver Rhinestone	GH-1895	$19.95	$4.95	$15.00
Talking Translator - 15 Languages	GH-1979	$69.95	$27.00	$42.95
Umbrella with LED Torch - Black	GH-1185	$19.95	$5.00	$14.95
USB Missile Launcher with Sound & CD	GE-4074	$39.95	$14.00	$25.95
USB Missile Launcher with Web Cam	GE-4084	$109.00	$37.00	$72.00
USB Pedometer with Rechargeable Software	GE-4093	$19.95	$5.00	$14.95
Voice Cards Suit JC-0186 Translator English/Spanish/Italian	JC-0188	$24.95	$9.00	$15.95
Wine Cooler - 6 Bottle 18Lt Capacity - 240VAC	GH-1372	$199.00	$79.00	$120.00

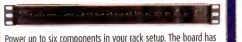
Be sure to check out the full range of Clearance lines in-store or on the Web. Many items only have one or two units in a couple of stores and you can get a fantastic bargain if you ask.
*Off Original RRP. Limited stock, no rainchecks, may not be available at all stores – call your local store to check stock details. Valid till 23rd October 2010 or while stocks last!

Limited stock on sale items.
All Savings are based on Original RRP

Jaycar Electronics
Better, More Technical

Rack-Mount 6 IEC Power Distribution Unit

new



Power up to six components in your rack setup. The board has 6 IEC outlets and mounting brackets at 90° so it can be mounted vertically or horizontally depending on your setup.

- Overload and surge protection
- 16A input
- 6 x IEC outlets
- Dimensions: 482(W) x 38(H) x 38(D)mm

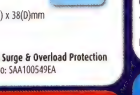
MS-4090

$99.95

Also available
New 6-Way 240V PDU with Surge & Overload Protection
MS-4094 $99.95 Approval No: SAA100549EA

Indoor Desk Thermometer

Handy desk or table-top thermometers. Measures degrees Celsius with hi and low memory. Tilting bail for standing on desk purposes. Indoor only or Indoor/outdoor type. Battery included.



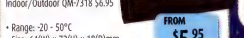
Indoor QM-7316 $5.95
Indoor/Outdoor QM-7318 $6.95

- Range: -20 - 50°C
- Size: 64(W) x 72(H) x 18(D)mm

FROM $5.95

LCD Probe Thermometer

Multi-purpose digital thermometer for the kitchen, lab, factory, workshop or barbeque. It measures in Celsius and Fahrenheit and fits in a pocket.



- Pocket clip
- Stainless steel probe
- Temperature range: -50 - 120°C, -58 - 248°F
- Accuracy: ±1°C
- Length: 150mm

QM-7314

new

$9.95

Sound Level Datalogger

Designed for recording and logging sound pressure level measurements for quality control, illness prevention, acoustic design or any other type of environmental sound measurement in domestic or industrial applications. The memory is able to record up to 129,920 samples with A or C weighting at intervals from 1 second to 24 hours and downloaded to a PC for later analysis. Modified to calculate SPL via proper log averaging rather than the inaccurate arithmetic average used on the original design. Battery and windsock included.

- USB interface
- Over-range indication
- System requirements: Windows 2000, XP, Vista.
- Dimensions: 140(L) x 28(W) x 21(H)mm

QM-1599

new

$149.00

4 Tray Tool/Storage Case

On-site storage of parts, tools, fishing tackle or anything else you need to tote around. Each compartment has a 233 x 122 x 32mm 13 compartment storage box for small items with dividers that can be removed to accommodate larger things. All the hinges and catches are the durable pintle type and the top tray has a generous 265 x 160 x 65mm space for ancillary items.

- Dimensions: 270(W) x 260(H) x 150(D)mm

HB-6302

$16.95

Ultra High Current Fuses

new

Patented technology designed for high current protection up to 250 amps found OEM on Ford, GM and Chrysler vehicles. Slo-Blo® feature eliminates nuisance blowing during temporary, short duration overloads. Commonly used for battery and alternator connections and other heavy gauge cables requiring ultra high current protection. Rated up to 32V AC or DC. Terminal studs 8mm.

High Current Fuse Holder	SF-1980	$19.95
Bolt-Down Fuse 125A	SF-1982	$9.95
Bolt-Down Fuse 250A	SF-1984	$9.95
Bolt-Down Fuse 500A	SF-1986	$9.95

FROM $9.95

7 Amp Hour 12 Volt Battery

Perfect for use as an emergency power source with alarms and computer peripheral terminals as well as a portable power source for portable DVD players, lights or solar panels for remote power.

- Leak proof construction
- Usable and rechargeable in any position
- Wide operating temperature range
- Long service life
- Size 151(L) x 65(D) x 101(H)mm

SB-2486 WAS $34.95

$24.95
SAVE $10.00

Hearing Loop Receiver Kit

new

Refer: Silicon Chip Magazine September 2010

A hearing loop is an inductive assisted listening system for the hearing impaired. They're typically installed in venues such as churches and conference rooms to enable listeners to receive in-ear communication via a wireless induction loop. You can now install this technology on your own TV, home theatre or hi-fi system. This will enable someone who's hard of hearing to hear at their own volume level without having to turn the volume up to a level too high for everyone else.

The receiver will drive a pair of headphone or earbuds from the signal picked up from the hearing loop. The whole unit is completely self-contained and can be carried around in a pocket or you can add a belt clip, so the user isn't constrained by a set of headphone leads. The kit is complete with case, label, PCB and components.

Note: Transmitter not included

- Current consumption: 10mA
- Frequency response: 100Hz - 5kHz
- S/N ratio: 67db
- Battery voltage indication: Down to 7V

KC-5497

$34.95

40 MHz Dual Channel Oscilloscope (CRO)

This dual channel oscilloscope has a bandwidth of 40MHz and an input sensitivity range from 5mV per division to 5V per division. A 'times 5' multiplier increases sensitivity to 1mV per division. The dual channel feature allows you to view two separate input signals and display them either individually, alternately, chopped or added together. The CRO has a number of trigger modes and will easily synchronise with TV sync pulses etc. It is housed in a pressed steel cabinet that incorporates a folding stand, carry handle, and handy mains cable storage on the rear feet. The control panel is uncluttered and neatly laid out and the 135mm screen has an integrated 10mm square graticule. Display area measure 8 x 10 divisions.

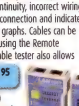
- Probes: Included
- Dimensions: 310 x 130 x 370 deep

QC-1924
WAS $799.00

$649.00
SAVE $150.00

MultiNetwork Cable Tester with Pin out Indicator

This multi network cable tester is designed to quickly test UTP/STP/Coaxial/Modular network cables by manually or automatically scanning the wires for continuity, incorrect wiring and polarisation. It will sequence each connection and indicate the connections via two 9-way LED bar graphs. Cables can be checked before or after installation by using the Remote Terminator (included). This ingenious cable tester also allows ground- testing of shielded twisted/pair cables.



- Main Unit: 104 x 62 x 26mm (LxWxD)
- Active Terminator: 100 x 30 x 25mm (LxWxD)
- Power Supply: 1 x 9V battery not supplied order Cat SB-2395 Energizer battery.
- Note: Not suitable for Live circuits

XC-5076

$39.95

Dual TO-220 Transistor Mounting Clamps

Allows easy clamping of dual TO-220 transistors to a heatsink with a standard M3 screw.

Packet of 10
HH-8605 $7.95
Packet of 100
HH-8607 $22.95

Solar Hydrogen Generation Kit

Another truly excellent educational alternative energy kit. Learn all about the finer points of hydrogen and solar-generated emission-free energy. The kit contains everything you need to get your own solar hydrogen experiment up and running. Instant renewable energy - just add distilled water. Comes complete with comprehensive, easy to read instruction manual.

Kit contents:
- 1 watt solar panel
- Connecting cables
- 0.3 watt fuel cell
- Hydrogen and oxygen tanks
- Gas container
- Tubing and syringe
- Comprehensive instruction booklet
- Solar panel size: 155(L) x 125(W)mm
- Recommended for ages 12+
- NOTE: You must use DISTILLED water - any other kind will destroy the membrane

KT-2524 WAS $99.95 Limited Stock

$45.00
SAVE $54.95

MASSIVE SAVING!

All Savings are based on Original RRP
Limited stock on sale items.

DON'T JUST SIT THERE, @BUILD SOMETHING

Spring Clean

SALE

Aluminium Indoor/Outdoor Camera Housing

This weatherproof enclosure is ideal for adapting our Professional range of CCD video cameras for commercial indoor or outdoor use. The enclosure features solid aluminium construction to protect the camera and a clear glass window protected by an integral sunshade. For indoor use, the sunshade can be easily removed. Water proof cable entry is achieved with screw down rubber seals and captive nuts are provided for mounting.

- Note: Sunshade is included in the price.
- Housing measures: 112mm(W) x 100mm(H) x 399mm(L) (Including sun shade)

QC-3330 WAS $39.95

$34.95 SAVE $5.00

External Camera Housing with Inbuilt Heater

This weatherproof enclosure is ideal for adapting our Professional range of CCD video cameras for commercial outdoor use. It features an internal heater to stop the housing humidifying which can cause clouding of the viewing glass and lens. Provided with an optional sun shade, it features waterproof seals and captive nuts provided for mounting.

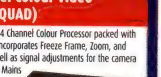
- Housing Measures: 410(L) x 118(H) x 107mm(W)

QC-3331 WAS $54.95

$49.95 SAVE $5.00

Four Channel Colour Video Processor (QUAD)

A professional quality 4 Channel Colour Processor packed with features. The system incorporates Freeze Frame, Zoom, and Picture in Picture as well as signal adjustments for the camera signals. 210mm wide. Mains adaptor included. See web site for full details



- Motion detection
- Event log
- Size: 210(W) x 130(D) x 44mm(H)

QC-3376 WAS $169.00

$139.00 SAVE $30.00

2.1mm Illuminated Polarity Sensing DC Connectors

Simplifies installation of CCTV cameras, access control and other security applications. These 2.1mm DC connectors detect and indicate the polarity of power connections with integrated LEDs. They also shine brighter as voltage increases. 5-30 VAC/VDC range, 1 metre lead length.

Available in two models:

DC Plug WQ-7288 $4.95
DC Socket WQ-7289 $4.95

Video Balun TX/RX 4 x BNC(male) to 1 x RJ45(female)

Connect up to 4 CCD cameras to a single CAT 5 cable. It simplifies CCD cabling and increase transmission distance by converting from coaxial to Cat 5 cabling. Cat 5 cable is low cost, easy to install and commonly used in computer and telecommunications and data industry. This technology is also used for multi-media presentations, desktop video conferencing or remote computer monitor video / audio setups. See website for specifications.

QC-3427 WAS $99.00

$79.00 SAVE $20.00

Down Light Style CCD Colour Camera

This 1/3 Sharp CCD camera incorporates a downlight holder for flush mounting on any ceiling or flat surface. The camera provides 0-90° adjustable pivoting camera head for securing that perfect angle. The holder is finished in polished metal and the unit operates down to 0.1 Lux courtesy of the 12 infrared LEDs which automatically turn on during low light levels. See our catalogue or website for full details.

QC-3503 WAS $249.00

$199.00 SAVE $50.00

High Power Infrared Spotlight - 50m Range

$179.00 SAVE $70.00

This spotlight will flood large areas with infrared light to make night time surveillance a breeze. It is fitted with and adjustable mounting bracket and is suitable for use in protected outdoor locations.

- Operating voltage 12VDC
- Illumination range more than 50 metres
- Size 110(D) x 195(L)mm

QC-3655 WAS $249.00

Four Zone Security Alarm with 2 Wire Technology

A simple DIY alarm. All system components (sensors, sirens) are connected to the control unit via a two core flat wire. The unit has a built- in keypad with status LED and three modes of operation (Home, Out, Off). All sensors and sounders are line protected so any attempt to interfere will sound the alarm.

Supplied with:

- Simple and effective Four-Zone system that enables you to set up multiple zones which can be monitored or enable independently (i.e. Upstairs/Downstairs or house & Garage etc.)
- Main control unit
- Two PIRs
- Four door or window contact switches
- External switch
- 240VAC Adaptor
- 50m two-core flat wire clips
- Screw/wall plugs
- Main unit: 160(H) x180(W) x35(D)mm
- Extra PIR with dual-element passive infra-red intrusion detector to suit LA-5476 $29.95

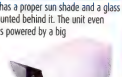
LA-5475

Buy this Alarm System and receive an extra PIR LA-5476 FREE!

$149.00

Metal Dummy Surveillance Camera

This unit will fool anyone. It has a proper sun shade and a glass window with a fake lens mounted behind it. The unit even includes a blinking LED that is powered by a big C battery so it lasts for ages.



- Requires 1 x C battery
- Camera measures: 60(W) x 55(H) x 190(L)mm
- Bracket: 160mm long

LA-5316 WAS $29.95

$23.95 SAVE $6.00

2MP Mini Digital Spy Recorder

The ultimate in discrete portable photo and video recording. Supporting up to 8GB of memory, it includes a 2GB Micro SD card, case, lanyard, two mounting brackets, software, USB and mains plugpack.

- High speed recording and fast response
- Supports AVI & JPEG formats
- Rechargeable Li battery lasts for 2 hours of non-stop recording
- Measures: 55(H) x 20(W) x 28(D)mm

QC-8001

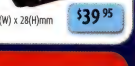
Waterproof Case 20m QC-8002 $39.95

Perfect for taking your camera sailing, surfing, caving or swimming. Housing is rated to 20m.

Buy a Mini Digital Spy Recorder and receive a FREE Waterproof Case & Save $39.95

CCTV Power Distributor Box

Makes distributing power to multiple CCTV cameras a simple matter. Simply connect a common source up to 30VDC and distribute it to up to 9 slave devices. Screw terminal connection.



- Individually protected PTC output
- Individual status LED indicators
- 1 - 30V AC or DC input
- Dimensions: 138(L) x 65(W) x 28(H)mm

MP-3351

$39.95

Security & Surveillance

www.jaycar.com.au

Limited stock on sale items.

All Savings are based on Original RRP

Jaycar Electronics
Better, More Technical

Touchscreen Car Multimedia Player

Comprehensive in-car connectivity - this impressive unit plays all the popular AV formats from just about any portable media or mass storage device. Plus it's Bluetooth-ready for handsfree communication when paired with a Bluetooth® enabled mobile phone. It's user-friendly touchscreen menu enables you to easily select and control several input play options. Mounting hardware, Bluetooth® bus and remote control included.

- Motorised 7" touchscreen LCD (480 x 234 pixels)
- 22WRMS x 4 channels (45W max each)
- Front panel USB, SD & aux-in
- 1 x rear camera input, 1 x video output

QM-3789 WAS $499.00

$419.00
SAVE $80.00

In-Dash Multimedia Player with USB and Bluetooth

A solid all-round performer, this in-car entertainment system plays all the popular multimedia formats and devices. It is Bluetooth® handsfree ready and comes complete with detachable anti-theft panel with colour LCD display and slimline remote control.

- Front USB port, SD/MMC card slot and aux-in
- PLL tuner with 18 x FM and 12 x AM presets
- DVD/R/RW, CD-R/RW playback
- Supports MP3, JPEG and WMA files
- 4 channels x 20WRMS output (40WRMS max)
- 4-band equaliser (classic, pop, rock, flat)

QM-3788 WAS $249.00

$199.00
SAVE $50.00

Composite Video & Stereo Audio Cat 5 Extender

With this Cat 5 video/audio extender, you can dramatically increase the flexibility of your home theatre or A/V installation. It allows you to greatly extend your cable range using conventional Cat 5e cable, enabling you to lengthen the propagation distance or pipe your A/V signals over conventional network cable runs.

- Impedance: Video 75 ohm, audio 600 ohm, UTP 100 ohm balanced
- Bandwidth: Video - DC - 12MHz, Audio - 50 - 15kHz
- Transmission distance over Cat 5e/6 UTP: up to 300m
- Dimensions: 72(L) x 64(W) x 28(H)mm

QC-3684 WAS $49.95

$39.95
SAVE $10.00

RESPONSE Precision Car Amplifiers

With improved heat sinks and upgraded low-profile chassis design, each model delivers surprising grunt and performance in a sleek and compact package that fits neatly under a car seat. All include gold plated power and speaker terminals and variable low pass filters. Plus our class AB amps come with variable high pass filters and pass through RCAs; while our class D subwoofer amps feature variable subsonic filter, phase shift and master/slave operation.

2 x 80WRMS Class AB Amplifier
Dimensions: 266(L) x 235(W) x 58(D)mm
AA-0450 $149.00

4 x 50WRMS Class AB Amplifier
Dimensions: 316(L) x 235(W) x 58(D)mm
AA-0451 $199.00

2 x 150WRMS Class AB Amplifier
Dimensions: 376(L) x 235(W) x 58(D)mm
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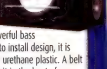

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SERVICEMAN'S LOG

Do-it-yourself servicing for old hifi gear

There's a lot of high-end audio gear around from the late 80s and early 90s but try getting it repaired these days. It's no wonder many people are now electing to tackle repair jobs themselves rather than consign what was expensive gear to the scrap heap.

Items Covered This Month

- Technics stereo system
- Onkyo TX-DS474 A/V receiver
- Resurrecting a BWD 804 oscilloscope
- Faulty PC power supply
- Philips FW-380C mini hifi system

Although it may now look a little dated, hifi audio gear from the 1980s and 1990s was capable of truly excellent performance. But what do you do if something goes wrong? Ditch it and buy something else (with possibly inferior performance) or try to get it repaired?

Fortunately, there are some people who elect to do the latter, even if they have to do the job themselves.

My first story this month comes from M. B. of Parramatta, NSW and concerns his battle with a 20-year-old Technics stereo amplifier. Here's how he tells it . . .

Technics stereo system

The cost of electronic equipment has dropped dramatically in recent years, making it less and less cost-effective to get gear repaired. If you have something that's a few years old, you can probably get an exact replacement on eBay for a lot less than the repair price. What's more, electronic repair shops are virtually extinct as I discovered when I tried to get a stereo amplifier repaired recently.

So why do we bother thinking about getting anything electronic repaired?

I have a 20-year old Technics stereo system (made up of separate units) which I hadn't used for quite a while. However, after a recent move, I decided to start using it again but as luck would have it, the main amplifier would only work for five minutes before it started to sound distorted and noisy.

I have worked on high-end medical electronics for some time now. This involves mostly sub-assembly replacement rather than component-level repair. Nevertheless, I thought it'd be interesting to have a crack at repairing the old amplifier.

The first thing to do was track down a circuit diagram. Trawling the internet turned out to be fruitless, so I had no option but to get it repaired. The next problem was to find an electronics repair business but that turned out to be a lot more difficult than I initially thought.

Eventually, I found a service centre and got the amplifier repaired. A number of electrolytic capacitors in the power supply had dried up and, on reflection, I could have just "shotgunned" it and replaced these myself, as they are always prime suspects. Anyway, I took it home where it worked well for a while.

Unfortunately, there was another problem lurking in the works because after a few months, the amplifier wouldn't turn on. Unwilling to spend another $100 on an old system, I once again started trawling the internet for circuits. I didn't really expect to find anything but decided that another 10 minutes of investigation wouldn't hurt. Eventually, however, I came across a site which supplied me with the service manual I required for $20.

The block diagram in this manual indicated that there was a power-on signal which came from the tuner, ie, the system is turned on by a switch on the tuner. A quick check of the amplifier's power supply indicated that it was OK but the enable/power-on signal to the control chip was missing.

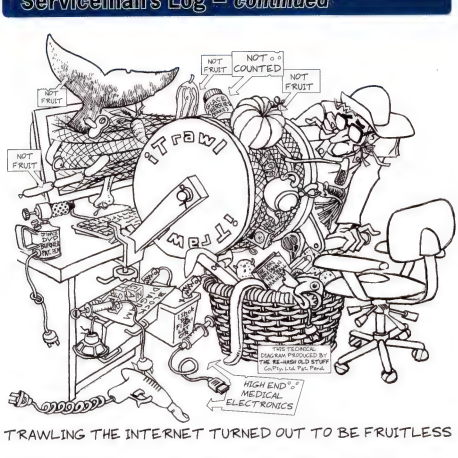
Tracking down the power switching transistor soon revealed the cause of the problem. This was a type of transistor I'd not come across before and is called a "BRT" or "Bias Resistor Transistor". These have bias resistors built into the transistor substrate. Apparently, the idea was to reduce the parts count on the PC boards.

Anyway, I noticed that the collector of this switching transistor was permanently low. By removing a few components, I eventually found that a daughter board, used for switching video signals, had a tiny piece of metal (source unknown) which was shorting between ground and the enable line to the power switching transistor. Removing this metal with a small-bladed screwdriver soon sorted that out.

The stereo system then went back into its cupboard and worked well for a few more weeks until, one day, I decided to change a CD and found the drawer wouldn't open. By now, it was tempting to simply throw in the towel and decide that the system was just too old to bother with. However, because I'd spent so much time on it already, I eventually decided that I may as well carry on.

I also thought that it would be easier now that I knew where to get the manuals from. The only problem was that Murphy's Law now kicked in and the previous website didn't have the manual for another component of the same stereo system! Fortunately, the internet gods looked after me again, because I quickly found another website with the very manual I needed.

This manual was quite good at ex-



TRAWLING THE INTERNET TURNED OUT TO BE FRUITLESS

plaining how to disassemble the CD player. The front of the unit actually hinges forward to allow the CD to eject and the operation switches are in the front panel.

It took quite a bit of digging to get to this PC board. The eject switch is part of a microcontroller switch matrix. However, while the other switches such as play, stop, pause, etc are straight push-on switches, the open/close switch has a time delay circuit. This circuit in turn drives a PNP transistor which shorts out the appropriate matrix lines when turned on.

When the switch is closed, the transistor is turned on for only a brief period. However, in this case, the circuit wasn't turning on for long enough – something I discovered by briefly shorting out the emitter and collector with a screwdriver.

Looking at the collector on a scope, the difference was that when the switch was pushed, the collector pulses would drop down towards 0V with scanning pulses visible. However, the pulse floor would not reach 0V, so the transistor was not being turned on for a long enough time.

The only capacitor in this part of the circuit was a 2µF electrolytic. Removing it and checking it with a capacitance meter revealed that it had dried out. A replacement fixed the problem and I walked confidently back into the lounge room to re-install the stereo. My wife was watching me put the unit together and I decided to show her that it was now working again, if only to prove how clever I was.

Guess what, it wouldn't open! Good thing I don't do this for a living I thought to myself and I lugged it back to the workbench.

The CD eject switch circuitry was still working fine and the open/close signals from the controller were at the right levels. I then followed the open signal down to an op amp which drives the eject motor drive transistors.

There are two resistors to the input of the op amp and when I connected a scope probe to monitor the voltage on one of these resistors, the eject button started working again! However, as soon as I removed the probe, it would stop working!

So was there some issue with voltage levels or was the probe loading the circuit? Both possibilities were unlikely! Suspecting a dry joint, I decided to put some sideways pressure on the resistor with a small screwdriver and hey presto, the eject button started working again.

There was nothing for it but to dismantle the CD player yet again to remove the PC board, although by now I could probably have done it with my eyes shut. Re-soldering the resistor had everything working fine again.

With some trepidation I returned to the lounge room once more to reinstall the system under the watchful eye of my wife. This time, all went well and I managed to get the system back together again with it still working.

But what are the odds of something like that happening? Two different faults on two different PC boards caused exactly the same problem, the second fault appearing just after the first had been fixed.

It's not the first time something like this has happened to me and it probably won't be the last!

Onkyo A/V receiver

Another contributor, M. O. of Wembley, WA also recently did battle with some audio gear, this time on behalf of a client. I'll let him tell it in his own words . . .

Despite the rapid advances in audio-visual (A/V) equipment, some owners still elect to have older units repaired. However, in this particular case, I suspect that the customer thought it would be an easy fix. His A/V receiver was simply not retaining its surround sound audio level settings when the unit was switched off using the front-panel on/off switch.

Apart from that, it was working perfectly so it couldn't be anything too complicated could it? Or so he reasoned.

The unit in question was an Onkyo Audio Video Control Receiver, model TX-DS474. And from past experience working on Marantz, Denon and Onkyo A/V gear, the major part of the repair has invariably involved dismantling the unit to get to the faulty part(s) and then re-assembling it afterwards.

There are also odd cases where it's virtually impossible to test a PC board without making up jumper cables for troubleshooting. As a result, fixing A/V equipment is nearly always time consuming and charging for the actual hours spent on a job is often out of the question if you want to retain a happy customer.

Fortunately, this particular repair job appeared to be an easy task from the outset. There was little doubt that it would be a back-up battery or a super capacitor failure. As a result, I took a look at the service manual and found that it all came down to a super capacitor identified as C7002 (0.047F) – part number 3000078T – on the display PC board.

The good thing was that I had a couple of these super capacitors on hand, so I didn't have to source the part. The bad news was that getting to this part is not an easy task. In fact, without a service manual, it would be like working around a maze.

Even with a service manual on hand, it was still an adventure each and every step of the way. Eventually though, I reached my destination but only after I removed the unit cover, the base screws, the front panel and the control knobs.

When I got there, I found that the super capacitor was leaking. I removed it and tested it on my high-capacitance tester and found that it only registered about 400µF. No wonder it was forgetting its settings.

Replacing the super cap was something of a challenge too, as it rested right on top of the fluorescent display unit and was close to adjacent parts. Nevertheless, I eventually managed to get the replacement part in after quite some time before beginning the lengthy task of reassembling the unit.

The big moment of truth came when it was time to power up the unit. It all went well and I left it running for some time to ensure that the super cap was sufficiently charged. During that time, I also adjusted the unit for different output level settings on the front, rear, centre and sub-woofer channels and kept a record of these settings.

I then removed the power cord from the wall outlet for another hour before reapplying power and checking to see if it had "remembered" the settings. They were all correct and I repeated the on/off test several times over the next few days before returning the unit to its owner.

RESURRECTING A SCOPE

Resurrecting a scope

What happens when you buy a piece of electronic equipment on eBay and it gets damaged in transit? Fix it of course, or at least that's what B. C. of Moss Vale, NSW did recently. Here's what happened . . .

My hobby is designing, building and repairing valve amplifiers and other equipment (both vintage and modern). Recently, my old oscilloscope packed it in and figuring that it wasn't worth fixing, I sought a suitable replacement on eBay. Not needing anything too fancy, I happily settled on an old BWD 804 oscilloscope which, according to the seller, was in good working order.

When it arrived, I unpacked it and plugged it in to check it out. However, when it was switched on, it immediately started smoking and then blew its fuse. So was the problem there when I purchased it or had the unit been damaged in the post?

I opened the case to find an obvious burnt-out resistor on the PC board. Fortunately, the manual had been supplied with the unit and I quickly identified the offending resistor and a nearby mate as being part of a resistive divider for the scope's CRT bias network.

This network consists of a chain of various resistors (both on the PC board and off it) plus potentiometers such as the Focus and Intensity controls. This divider chain is fed with a -1500V rail from the power supply. And although it looks relatively simple on the circuit diagram, in practice it runs around the interior of the chassis, from the main PC board through to the front panel controls.

The fault-finding procedure simply

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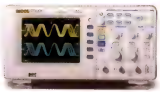

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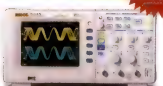

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involved checking out this chain of components to find the culprit. This quickly revealed that the Intensity pot had a short to chassis on one of its three terminals. This short was duly removed and in doing so, a tiny metallic speck fell from the terminal to ground, never to be seen again.

Although this might not seem such complex a fault for even the average serviceman, it still amazes me that dear old Murphy had to raise his head again in this case. After all, what are the odds that such a tiny speck of wire or metal shaving could find its way to such a critical part of the circuit and lodge there, to ultimately damage several parts (the pot itself and two resistors). I reckon the odds against this happening must have been more than a million to one but there's no way I'd win a lottery.

There was no way I could blame the seller for the fault. The problem had obviously arisen when the loose speck of metal moved and lodged between the pot terminal and ground while the unit was in transit.

Faulty PC supply

My next story comes from W. H. of Ingle Farm, SA and concerns an old PC that he wanted to keep going for a few more years. Frankly, I've always been of the opinion that too many PCs are consigned to the scrap heap when they can be easily repaired or cleaned up by reinstalling the operating system. That particularly applies if a PC is only ever used for email, browsing the Internet and writing the odd document.

Keeping old PCs going a few more years can not only save dollars but reduces our landfill problems as well. Anyway, I'll let W. H. get on with it . . .

My old faithful PC was getting on a bit and so I recently decided to upgrade to a later model with a faster processor, a better video card and more RAM. This would become my main machine but I still wanted to keep old faithful going for certain tasks.

During the changeover procedure, I removed the hard disk drives (HDDs) from my old PC and temporarily installed them in the new one. Then, after all the necessary files had been copied across, I reinstalled them in the old PC again.

That's when I noticed that the old PC was no longer behaving normally. When the power switch was pressed, it looked like the PC initially wanted to fire up but that was as far as it got before immediately shutting down again.

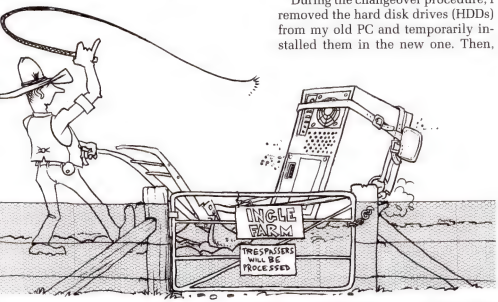
It was then that I remembered it had played up this way some months before. However, by flicking the switch a few times, I could always make it come on and stay on. This led me to conclude that the switch itself must be sticking so this was the first thing to check.

I removed the front panel and the switch assembly and checked the latter with my digital multimeter. It appeared to be OK but I decided to replace it with one I had on hand anyway. That made no difference, so it was time to look elsewhere. It was beginning to look as though the supply itself was at fault, although a motherboard fault was another possibility.

Next, I removed the side panels and then tried firing the computer up again. This time, it came on but then made a loud clicking sound from the vicinity of the power supply just as it was starting to load Windows XP. It then crashed but the clicking noise remained.

At this stage, I decided to gamble on a new power supply for this 8-year old PC. The new unit cost $49 and was rated 80W higher than the original supply.

Removing the old supply was straightforward but I had to slightly trim the lock-down clip on the new supply's main power connector in order to clear an electrolytic capacitor on the motherboard. And that was it – old faithful now fires up first time every time and has a few years of useful life left in it yet.



~ AN OLD PC HE WANTED TO KEEP GOING FOR A FEW MORE YEARS

Philips mini hifi system

And now for a change of pace, here's a story from K. R. of Lara, Victoria, concerning a faulty CD player . . .

Back when I was in high school, I saved all my pocket money to purchase an all-in-one audio system. Basically, I wanted something capable of blasting out Led Zeppelin and Pink Floyd at the sort of volume that would ensure my parents knew I was home. My choice of equipment: a Philips FW-380C mini hifi system.

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in *The Serviceman* column in SILICON CHIP? If so, why not send those stories in to us? It doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics.

We pay for all contributions published but please note that your material must be original. Send your contribution by email to: editor@siliconchip.com.au

Some years later, the system travelled to university with me, where its auxiliary input made a great set of speakers for my computer. However, somewhere along the way, the CD player stopped reading discs and eventually it wouldn't even power on.

Last year, I tried to off-load it at a car boot sale for $40 but no-one wanted a stereo system with that kind of fault. As a result, the system sat unloved in my garage until I eventually decided it was time to open it up and see if anything glaringly obvious stood out.

After removing several screws and disconnecting some cables, I could see an area on the main audio board that looked like it had been hit with an open flame! The fried components occupying this space included two resistors, four transistors and a zener diode.

After a little more searching, I also came across a large capacitor (4700µF 35V) that looked as though it had been glued to the PC board. However, I quickly realised that the "glue" was actually from the capacitor itself – some of its innards were now on the outside.

A quick search through my limited stock of components revealed I had a suitable electro to replace the leaky one but no resistors, transistors or diode for the fried area of the audio board. In the end, I decided to see what would happen if I just replaced the leaky capacitor. After all, I really had nothing to lose.

Anyway, I replaced the leaky 4700µF electro and applied power. To my surprise, the CD carousel rotated and the system went into the store demo mode! It was alive again.

Next, I switched to tuner mode, and successfully tuned in a local radio station. Unfortunately, after some more tuning, the system then dropped out briefly and went back to demo mode. I then quickly tried the CD player but for each of the three discs in the carousel the display said "No disc".

I powered down and made the trip to my local electronics store for parts. The four BC547B and BC337 transistors, along with a couple of resistors, were easy finds. However, the zener diode (labelled BZV55F) was a different story. The closest I could find was an 1N751A (400mW, 5.1V). It would have to do.

Returning home again, I quickly replaced the faulty transistors and resistors and tried again. This time I had somewhat more success. There were now no more drop-outs back to demo mode but it still wouldn't play CDs. I could see the disc try to spin up but it could only manage a wobble before the display again said "No disc".

It had to be the zener, so it was next to be swapped. By now, I was an expert at pulling the system apart and putting it back together but even with the replacement zener diode, it was still displaying "No disc".

A quick Google of "philips hifi no disc" turned up the obvious – a dirty lens. I cleaned the lens with a cotton bud and sure enough, the CD player was back in business. Sometimes the simplest things are the least obvious when you are troubleshooting gear like this!

Encouraged by my success, I then decided it was worth parting with $6 to purchase a pack of replacement drive belts for the cracked and broken cassette deck belts. I will probably never use the decks but the satisfaction of bringing my childhood "rock box" back to life – complete with cassette decks – made me do it. SC

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By NICHOLAS VINEN

Two TOSLINK–S/PDIF Audio Converters

Do you have a DVD or CD player with a TOSLINK (optical) output but only coaxial S/PDIF inputs on your amplifier? Or do you have the opposite problem? What about hum from your speakers when running digital audio via a coaxial cable? With these simple converters you can easily solve these problems.

TWO DIFFERENT CIRCUITS are described here: (1) a S/PDIF to TOSLINK Converter; and (2) a TOSLINK to S/PDIF Converter. The first converts a S/PDIF (coaxial) signal to an optical signal, while the second does the opposite. Each converter is built on a separate circuit board and is powered via a small AC or DC plug-pack supply.

Transmitting audio digitally is great because in most cases there is no signal degradation. The best transmission medium is optical fibre (ie, TOSLINK) because the two connected devices remain electrically isolated. However, it's not without its drawbacks – the cables tend to be expensive and can not be cut to length.

Also, because there are multiple competing standards (coaxial, TOSLINK and HDMI to name three), you won't always have the same connectors at both ends.

In fact, these issues are so common that several SILICON CHIP staff members were in the market for digital audio converters. They are commercially available but the retail cost of around $60 for a bidirectional unit seems high, considering that we can put together something similar for much less than that.

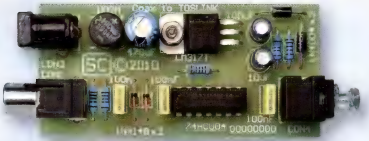
Advantages

A similar design to the commercial unit was published in June 2006 (Two-Way SPDIF/Toslink Digital Audio Converter). This is a smart-looking little device in a small plastic box. Unfortunately, kits for that project are no longer available and neatly drilling

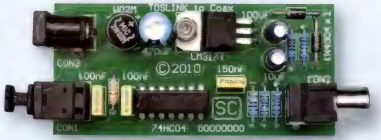
Digital Audio Signal Formats

The digital audio signals found in domestic equipment are all in the form of SPDIF (Sony/Philips Digital Interface) bitstreams – either as 400mV electrical signals sent along 75-ohm coaxial cables or as optical signals (pulses of 660nm red light) sent along fibre-optic cables. The optical signal form is often called "TOSLINK".

Although domestic digital bitstream audio is split almost equally between the coaxial and optical forms, they're both virtually identical in terms of the encoding and serialisation used. So it's relatively easy to convert between the two, in either direction.



This is the S/PDIF to TOSLINK Converter board. It accepts digital audio at the RCA socket at left and outputs an optical signal at the TOSLINK transmitter at right. Power is fed in via the on-board socket at top left.



The companion TOSLINK to S/PDIF Converter works the other way – ie, it converts an optical signal to a S/PDIF signal and outputs it at the RCA socket at right.

Rather than mount them in a case, the converter boards can be sleeved in heatshrink and hidden behind the A/V equipment they connect to.

the boxes from scratch seems like too much work.

Also, there is a problem with bidirectional units due to the fact that the shields of the coaxial input and output sockets are typically connected together within the converter. As a result, if both sections are used, there is still the possibility of an earth loop being formed, resulting in hum problems.

With these new designs, you can build just one converter or several, depending on your exact requirements. They are designed to be housed inside heatshrink plastic tubing so there is no need to drill a box and this keeps the unit cost low as well as simplifying the board shape.

We have also made some minor improvements over the earlier design. These versions can be powered from a wider range of plugpacks, so chances are you already have a suitable power supply spare from another piece of equipment. They also use less power, making it easy to run several from a single plugpack.

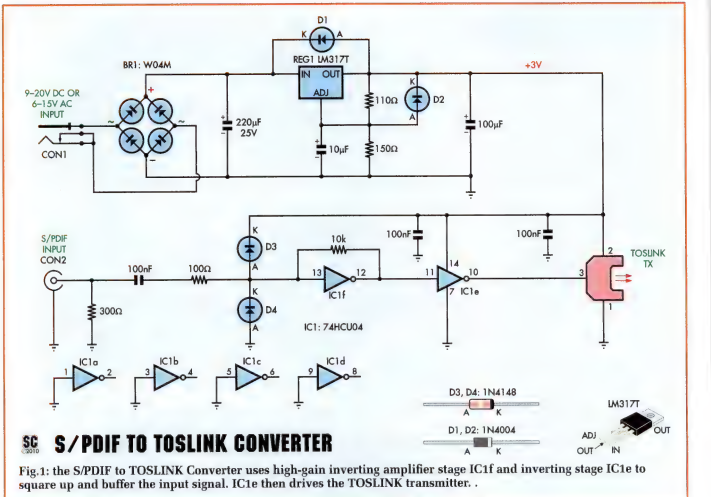
In addition, TOSLINK modules from both Jaycar and Altronics can be used – in fact virtually any are suitable. Some modules require a 3V supply and some a 5V supply. Only a few resistors in the on-board regulator circuit need to be changed to suit either type.

Uses

The most obvious use for a digital audio converter is when you want to connect two pieces of equipment and one has a TOSLINK connector while the other has a coaxial socket. However, there is another purpose; when either converter is used, the two pieces of equipment will be electrically isolated. This means that as long as you are careful to avoid unintentionally connecting multiple signal earths via the converter power supply, an earth loop can not be formed, regardless of the connection method at either end.

Another useful application is for sending an optical audio signal from one side of a room to the other or even into another room. While wall plates are available for sending TOSLINK over Cat5 network cable, they are expensive and require a power supply at each end which will constantly draw power unless an additional wall switch is installed to turn them on and off.

With a pair of these converters, you can first convert the TOSLINK signal to a S/PDIF signal and then feed it into a wall plate via a 75Ω RCA-to-



S/PDIF TO TOSLINK CONVERTER

Fig.1: the S/PDIF to TOSLINK Converter uses high-gain inverting amplifier stage IC1f and inverting stage IC1e to square up and buffer the input signal. IC1e then drives the TOSLINK transmitter. .

RCA lead (composite video leads are suitable). The signal is then carried over standard 75Ω coaxial cable (eg, RG-6/U or RG-59/U) to the other wall plate. From there, it's then fed via another RCA-to-RCA lead into the second converter and converted back to optical (TOSLINK) format.

The power supply at each end (typically a plugpack) can easily be switched off at the wall, along with the sending and receiving equipment, to save power when it is not in use.

Performance

We tested both converters with Dolby Digital, DTS and linear PCM audio data. The PCM tests included both 48kHz 24-bit stereo and 96kHz 24-bit stereo audio streams.

Both units were able to correctly handle all of these streams with one exception: if the TOSLINK to S/PDIF converter is built with a receiver module rated to handle 8Mbps (such as the Altronics Z1602), then it may not work with 96kHz 24-bit linear PCM.

This type of audio has a bit rate of 6.144Mbps (96,000 x 2 x 32) so it seems that the nominal 8Mbps unit should be able to handle it. However, that specification is listed as a maximum rather than typical rating and the measurement conditions involve a cable only 1m long and a stated duty cycle of 50%. In reality, NRZI-encoded data, if considered as being at fixed frequency, has a variable duty cycle.

We also tested a 16Mbps receiver (Jaycar ZL3003) and this handled the 96kHz PCM stream correctly. However, unless you are using a DVD-audio player or computer sound card with 96kHz capability, the highest sample rate you are likely to transmit is 48kHz (with a bit rate of 3.072MHz). In this case, either receiver unit is suitable. The data in Dolby Digital and DTS streams is compressed, so their bit rates are lower again.

Power supply

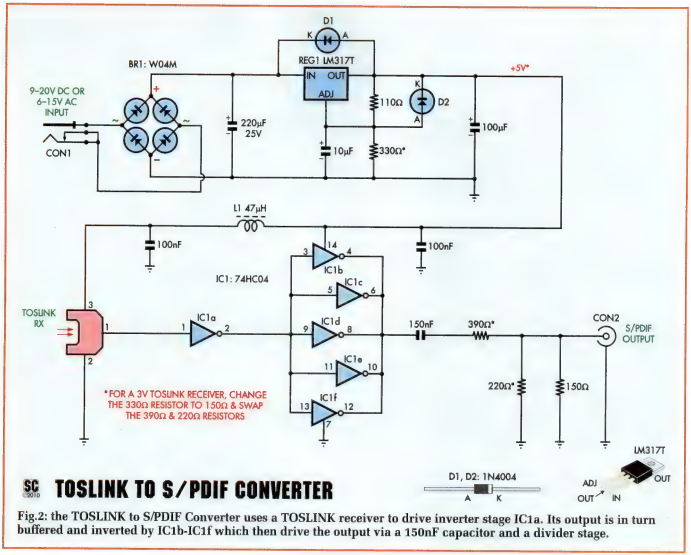
Either an AC or DC plugpack can be used to power these converters. The acceptable voltage range is 6-15VAC for AC plugpacks and 9-20VDC for DC plugpacks. The current consumption is below 20mA in each case.

Power is applied to each converter board via a 2.5mm ID DC socket which suits many but not all plugpacks. In some cases, an adaptor plug may be required or you will have to change the DC connector on the plugpack to suit the on-board socket.

If you are the type of person who keeps plugpacks from defunct equipment then you will almost certainly have something suitable. Otherwise, buy the cheapest option which suits the above requirements (eg, Altronics M8922 or Jaycar MP3020) but if it has a fixed plug, check that it's a 2.5mm type.

Circuit description

Fig.1 shows the S/PDIF to TOSLINK Converter circuit. Either AC or DC power is supplied via CON1, a PC-mount DC connector. If the supply is AC, it is rectified by bridge rectifier BR1 and filtered by a 220µF capacitor to form an unregulated DC supply. If DC is supplied from the plugpack, it



SC 10/10 TOSLINK TO S/PDIF CONVERTER

Fig.2: the TOSLINK to S/PDIF Converter uses a TOSLINK receiver to drive inverter stage IC1a. Its output is in turn buffered and inverted by IC1b-IC1f which then drive the output via a 150nF capacitor and a divider stage.

charges the 220µF capacitor directly via BR1 and the connector polarity does not matter because only two of the diodes within BR1 will conduct.

Which two diodes actually conduct depends on whether the supply plug is centre positive or negative. Because there are always two diodes in series with the supply, its voltage is reduced by around 1.4V (two diode drops) which is more than the typical 0.7V loss with a single reverse polarity protection diode. However, because the circuit runs at such a low voltage, this doesn't really matter.

The filtered DC supply is regulated to around 3V by adjustable regulator REG1. Its output voltage is set by the ratio of the two resistors on its OUT and ADJ terminals and is (150Ω/110Ω + 1) x 1.25V = 2.95V. In practice, it's slightly higher than this due to the leakage current from REG1's adjust pin.

The 100µF capacitor provides output filtering for REG1 while the 10µF capacitor bypasses the ADJ (adjust) pin, improving supply ripple rejection. Diodes D1 and D2 protect REG1 from the charge stored in those two capacitors should its input be shorted. That is unlikely because of BR1, however they are cheap insurance and make the regulator circuit virtually "bulletproof".

Signal conversion

The S/PDIF audio signal enters the board via RCA socket CON2. It is a bi-phase encoded digital signal (also known as "non-return to zero" or NRZI encoding) which, when terminated with 75Ω, has a voltage swing of about 0.5V peak-to-peak. Its frequency depends on the data format and sample rate but is typically between about 0.9MHz and 6MHz.

IC1f is part of a 74HCU04 unbuffered inverter IC and is configured as a high-gain inverting amplifier. The incoming digital signal is AC-coupled to its input via a 100nF capacitor. The 300Ω and 100Ω resistors together set its input impedance to around 75Ω, matching the source and cable impedance for minimum signal attenuation.

Diodes D3 & D4 protect IC1f should a higher amplitude signal be accidentally connected to CON2 (or if a high-voltage spike gets in for some other reason). IC1f's closed loop gain is set by the ratio of the 10kΩ and 100Ω resistors, ie, it is around 100. This is enough so that its output swings fully between the supply rails with a 0.5V input signal while also squaring up the digital signal.

This output is buffered and inverted again by IC1e, so that its polarity is the same as at the input (although with NRZI encoding, polarity doesn't matter). That signal is then sent directly to the TOSLINK transmitter which modulates its output LED to transmit the digital signal over optical fibre.

Note that we have used a 74HCU04

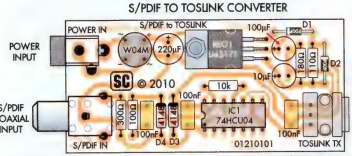
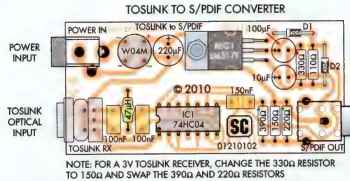


Fig.3: follow this parts layout diagram to build the S/PDIF to TOSLINK Converter circuit. It converts coaxial SPDIF signals to optical format.



NOTE: FOR A 3V TOSLINK RECEIVER, CHANGE THE 330Ω RESISTOR TO 150Ω AND SWAP THE 390Ω AND 220Ω RESISTORS

Fig.4: this is the layout for the TOSLINK to S/PDIF Converter circuit. It converts optical (TOSLINK) signals to coaxial format. Note that you have to swap some resistor values if you are using a 3V TOSLINK receiver.

inverter in this circuit rather than a 74HC04 (which is easier to get). The reason for this is that the 74HC04 has a much higher open loop gain and larger phase shift (ie, signal delay) between its input and its output. That's because each section of the 74HC04 is actually three CMOS inverters in series. This is done to reduce the input capacitance and improve the output drive strength, which are desirable properties in a digital circuit.

However, these factors combine to make it unstable in this type of configuration and even a small amount of noise picked up at its input can cause the output to oscillate at a very high frequency (tens of MHz). This increases the circuit's power consumption when there is no input signal and also causes it to emit more electromagnetic interference (EMI).

The 74HCU04 IC is a little different, as each of its sections is just a single CMOS inverter. These devices are primarily intended for use in crystal oscillator circuits but they also work well for amplifying low-level digital signals, as in this case. So while a 74HC04 may work in this circuit, it is undesirable to make the substitution for the reasons stated above.

TOSLINK to S/PDIF converter

Now let's take a look at the TOSLINK to S/PDIF Converter – see Fig.2.

The power supply is identical to that used in Fig.1 except that its output voltage must be tailored to suit the particular TOSLINK receiver used. For 5V receivers such as the Jaycar ZL3000, 110Ω and 330Ω resistors are used at its OUT and ADJ terminals since (330Ω/110Ω + 1) x 1.25V = 5V. For 3V receivers such as the Altronics Z1602, the same resistors are used as for the other converter (ie, the 330Ω resistor is changed to 150Ω).

Inductor L1 and its associated 100nF capacitor form an LC low-pass filter. This isolates the TOSLINK receiver's supply from the main supply so that switching noise can not be coupled back into it and upset its internal high-gain amplifier. That amplifier is fed from a phototransistor which picks up the bi-phase signal from the optic fibre, converting it to a digital electrical signal at its pin 1 output.

This signal is now buffered and inverted by IC1a (part of a 74HC04 hex inverter IC) and then again by the remaining five inverter stages. These are hooked up in parallel to provide enough current to drive a 75Ω load.

Using The Altronics 3V TOSLINK Receiver

The parts layout shown in Fig.4 for the TOSLINK to S/PDIF Converter suits a 5V TOSLINK receiver (eg, Jaycar ZL3003). Alternatively, if you are using a 3V TOSLINK receiver (eg, Altronics Z1602), be sure to change the indicated resistor values.

Both the Jaycar and Altronics TOSLINK transmitters (Cat. ZL3000 & Z1601 respectively) operate from 3V, so no such changes are required on the S/PDIF to TOSLINK Converter board (Fig.3).

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
150nF	0.15µF	150n	154
100nF	0.1µF	100n	104

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	10kΩ	brown black orange brown	brown black black red brown
❑	1	330Ω	orange orange brown brown	orange orange black black brown
❑	1	300Ω	orange black brown brown	orange black black black brown
❑	1	220Ω	red red brown brown	red red black black brown
❑	1	150Ω	brown green brown brown	brown green black black brown
❑	1	110Ω	brown brown brown brown	brown brown black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

The signal at the inverter outputs is then AC-coupled via a 150nF capacitor, so that it is centred about ground potential, and its amplitude reduced by a resistive divider made from three resistors. This divider also provides the correct output impedance of around 75Ω (actually, 72.5Ω assuming the resistors are accurate).

Because the circuit can operate from either a 3V or 5V supply rail (depending on the TOSLINK receiver used), the divider ratio must be configured to provide the correct output signal level. The resistors in Fig.2 are shown configured for a 5V supply rail.

The 220Ω and 150Ω resistors in parallel are equivalent to an 89Ω resistor so the 5V peak-to-peak output from the inverters is translated to 5 x 89/(390 + 89) = 0.929V peak-to-peak. This is close enough to the 1V desired. Since the source impedance is 75Ω and the signal is terminated by 75Ω at the other end, the receiver can therefore expect to receive a signal which is a little under 0.5V peak-to-peak.

For a 3V supply rail, we swap the 220Ω and 390Ω resistors. The two resistors in parallel then form a 141Ω equivalent resistor and the formula becomes 3 x 114/(220 + 114) = 1.024V peak-to-peak, again within the acceptable range.

Construction

The two PC boards are the same shape and size and the construction procedure is similar. The S/PDIF to TOSLINK Converter board is coded 01210101, while the TOSLINK to S/PDIF Converter board is coded 01210102. Both measure 74 x 34.5mm.

Fig.3 shows how to build the S/PDIF to TOSLINK Converter, while Fig.4 is the parts layout for the TOSLINK to S/PDIF Converter. Whichever board you choose to build, start by checking the copper tracks to ensure that there are no breaks or short circuits. Also check that the holes are drilled to the correct size and that the components fit, especially the three connectors, the regulator and the bridge rectifier.

That done, fit the resistors. Check each with a multimeter set to Ohms before installation and **remember to change three resistors on the TOSLINK to S/PDIF Converter board if you are using a 3V TOSLINK receiver – see Fig.2 & Fig.4.**

The discrete diodes can go in next. Be sure to install them with the correct polarity and don't get the 1N4004 and 1N4148 diodes mixed up on the S/PDIF to TOSLINK Converter board.

If you are building the TOSLINK to S/PDIF Converter, install the 47μH axial inductor (L1) next. It looks similar to a resistor but is usually "fatter" and may also be a different colour.

Now mount the 74HCU04/74HC04 IC. Check that it is correctly orientated and be sure to push it all the way down onto the PC board fully before soldering all 14 pins.

The LM317T regulator is next on the list. To install it, first bend its leads down at right-angles 6mm from its body, then fit it to the PC board and secure its metal tab using an M3 x 10mm machine screw, nut and shakeproof washer. Do the nut up firmly, then solder and trim the three leads.

Do not solder the regulator's leads before securing its metal tab to the board. If you do, you could crack the copper tracks of the PC board as the nut is tightened down.

Parts List

S/PDIF to TOSLINK Converter

1 PC board, code 01210101, 74 x 34.5mm
1 black switched PC-mount RCA socket (Jaycar PS0279, Altronics P0145A)
1 TOSLINK transmitter (Jaycar ZL3000, Altronics Z1601)
1 2.5mm ID PC-mount DC socket
1 M3 x 6mm machine screw
1 M3 shake-proof washer
1 M3 nut
1 75mm length of 30mm diameter heatshrink tubing

Semiconductors

1 74HCU04 hex unbuffered inverter IC (IC1)
1 LM317T adjustable regulator (REG1)
1 W04(M) bridge rectifier (BR1)
2 1N4004 diodes (D1, D2)
2 1N4148 diodes (D3, D4)

Capacitors

1 220μF 25V electrolytic
1 100μF 16V electrolytic
1 10μF 16V electrolytic
3 100nF MKT

Resistors

1 10kΩ
1 300Ω
1 150Ω
1 110Ω
1 100Ω

Alternative parts: W04(M) may be substituted with W02(M), W06(M), W08(M) or W10(M)

TOSLINK to S/PDIF Converter

1 PC board, code 01210102, 74 x 34.5mm
1 TOSLINK receiver (Jaycar ZL3003, Altronics Z1602)
1 black switched PC-mount RCA socket (Jaycar PS0279, Altronics P0145A)
1 2.5mm ID PC-mount DC socket (Jaycar PS0520, Altronics P0621A)
1 47μH axial RF inductor (L1)
1 M3 x 6mm machine screw
1 M3 shake-proof washer
1 M3 nut
1 75mm length of 30mm diameter heatshrink tubing

Semiconductors

1 74HC04 hex inverter IC (IC1)
1 LM317T adjustable linear regulator (REG1)
1 W04(M) bridge rectifier (BR1) (Jaycar ZR-1304, Altronics Z0073)
2 1N4004 diodes (D1, D2)

Capacitors

1 220μF 25V electrolytic
1 100μF 16V electrolytic
1 10μF 16V electrolytic
1 150nF MKT
2 100nF MKT

Resistors

1 390Ω
1 330Ω (for 5V TOSLINK receiver)
1 220Ω
1 150Ω (2 for 3V TOSLINK receiver)
1 110Ω

Alternative parts: W04(M) may be substituted with W02(M), W06(M), W08(M) or W10(M); 47μH axial RF inductor may be substituted with 68μH or 100μH

Using A Single Plugpack With Multiple Converters

IF YOU REQUIRE multiple converters in one location, they can be powered from a single plugpack using a "Y-cable". However, you have to be careful that this arrangement does not introduce any earth loops. It's just a matter of ensuring that no two converters share a plugpack if one has a coaxial cable connected to a power amplifier while the other has a coaxial cable connected to a signal source (eg, DVD player).

The power splitter (Y) cable shown here was made using two 2.5mm ID (inner diameter) DC plugs, one in-line 2.5mm ID DC socket and approximately 1m of twin core flex, which can be salvaged from a dead plugpack (including one of the DC connectors).

Begin by cutting the cable into three sections of roughly equal length. Split the wires apart at each end and strip the insulation back. You will need to split the wires by a few centimetres to allow enough length to slip heatshrink over the leads while leaving the exposed ends far enough away so that the heatshrink doesn't shrink prematurely when soldering.

Next, unscrew the plastic shell from each connector and pass one of the cables through it. Slip a 20mm length of 2.5mm diameter heatshrink over one lead and solder that wire to the smaller of the two tabs on the connector. That done, slide the heatshrink tubing over the soldered joint and the metal tab and shrink it down.

Next, solder the other wire to the larger tab and crimp the metal clamp over the cable to hold it in place. Make sure the two conductors can not contact each other, then screw the plastic cover back into place.

Once all three wires have been soldered to the connectors, slide a 40mm length of 5-6mm diameter heatshrink onto the line socket cable and two 20mm lengths of 3mm diameter heatshrink over the individual leads. Twist all three positive wires together (with the line socket cable facing the opposite direction to the other two) and apply solder to the joint – an alligator clip stand will help hold the wires steady.

Check that all three centre pins are electrically connected and then shrink the smaller piece of heatshrink tubing over the solder joint. Now repeat this procedure for the three negative wires and then shrink the larger diameter insulation over both joints and the cable is complete.

Now install the bridge W04M rectifier. Make sure that the "+" marking on the top of the device lines up with the "+" on the layout diagram and check that it is correctly seated on the PC board before soldering its pins.

Follow this by fitting the three MKT capacitors (note the location of the 150nF capacitor on the TOSLINK to S/PDIF Converter). After that, you can mount the electrolytic capacitors, being careful to check their orientation.

The three connectors can now be fitted. Ensure that they are pushed down fully onto the PC board and are parallel with the edge before soldering their pins. The plastic posts on the RCA socket should go most of the way through the holes on the board (you may have to push it down fairly hard to get it to fit). Similarly, the DC socket may need to be pressed down firmly, as it can be a tight fit.

Use a generous amount of solder for the larger pins on the both DC and RCA sockets to ensure they are well-anchored.

The TOSLINK transmitter on the S/PDIF to TOSLINK Converter board is initially held in place with two plastic posts which snap into the appropriate holes. It is then just a matter of soldering the three pins. By contrast, the TOSLINK receiver on the TOSLINK to S/PDIF Converter is held in place by two large metal pins. They should be soldered first, after which the three signal pins can be soldered.

Testing

That completes the board assembly which should now be carefully checked for errors. That done, apply power and test the adaptor before encapsulating it in heatshrink tubing. During this test, take care to ensure that the parts cannot short against any metal objects, especially on the underside of the PC board.

It is also a good idea to check the underside of the PC board to make sure that there are no long protruding pins which may later pierce through the heatshrink insulation. If there are, cut them off short with side-cutters.

Once you have confirmed that the converter is functioning correctly, cut the heatshrink tubing to a length of 75mm, slide it over the unit so that it projects evenly over both ends and apply some gentle heat (eg, from a hair drier). Be careful not to bump the heatshrink out of position while doing this and be careful not to overheat it if using a hot-air gun.

That's it! If you need additional converters, just build some more. They should each take no more than about 30 minutes to assemble. SC

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

PIC-based water distributor

This circuit was made up to water a vegetable patch and a couple of flower beds on a suburban block. It is powered from a 12VAC 30VA garden transformer plugged into a 240VAC digital timer set to turn on for 15 minutes every 24 hours.

A bridge rectifier (BR1) and 2200µF capacitor provides 17VDC power to the circuit. This is regulated to +5V by a 7805 regulator (REG1) to supply a PIC16F628A microcontroller.

The PIC outputs are wired into a Darlington transistor array to boost current drive to switch on solenoid valves. The 19mm solenoid valves (24VAC 8VA) are commonly available from hardware stores such as Bunnings (eg, Irritrol 1012316 or HR Products MV75B) and are powered from the 17V DC.

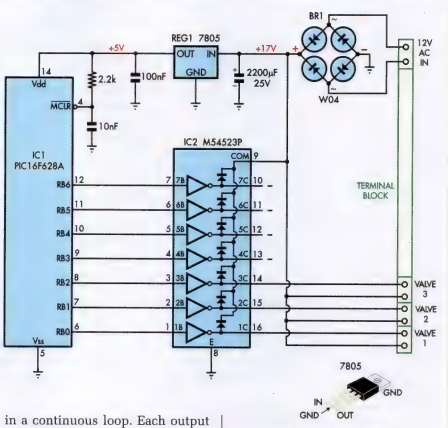
Note that AC solenoid valves also work well on DC.

When the digital timer turns on, power is applied to the circuit from the transformer and a power-up reset is applied to the PIC microcontroller via pin 4. The software routine (see below) causes the RB0 to RB2 outputs on the microcontroller to go high in sequence, then repeat in a continuous loop. Each output is on for five minutes but this could be easily changed to supply more or less water to individual beds.

The circuit can be expanded to turn on up to seven valves, limited by the number of outputs on the Darlington array. The digital timer can be set for 30 minutes if double the watering time is required.

David Bathgate,
Oatley, NSW. ($45)

Note: the software is listed below and can also be downloaded from the SILICON CHIP website.



Program Listing: PIC-Based Water Distributor

```
#include <htc.h>
#include <pic16f62xa.h>
__CONFIG(INTIO & WDTDIS & PWRTDIS & MCLREN & BORDIS & LVPDIS & UNPROTECT);
#ifndef _XTAL_FREQ
#define _XTAL_FREQ 4000000    //required to calibrate __delay_ms()
#endif
#define bitset(var, bitno) ((var) |= 1UL << (bitno));
#define bitclr(var, bitno) ((var) &= ~(1UL << (bitno)));
int i;

void delay5(void)
{                             //five minute delay
for(i = 0; i <= 3045; i++)    //adjust for 5 minute delay, i = 3000±60
  __delay_ms(100);
}
void main(void)
{
TRISB = 0b11111000;           //port directions: 1=input, 0=output
PORTB = 0b00000000;
while (1){
bitset(PORTB,0);              //valve1 ON
delay5();
bitclr(PORTB,0);              //valve1 OFF
bitset(PORTB,1);              //valve2 ON
delay5();
bitclr(PORTB,1);              //valve2 OFF
bitset(PORTB,2);              //valve3 ON
delay5();
bitclr(PORTB,2);              //valve3 OFF
}
}
```

Auto-sensing master/slave power control

This unit will enable peripheral equipment to be fully turned off once the master device has been turned off or put into standby mode. It uses two transformers, one to power the device and one to provide sensing.

Transformer T1's primary is connected in series with the Neutral lead of the master device. When the power control unit is first turned on (or reset) with the master device (in "off" or "standby" mode) plugged into the "master" socket, the standby current of the master device is sensed by T1.

The secondary of T1 applies this signal to the non-inverting input of op amp IC1 which amplifies the signal. IC1's output passes to IC2 which buffers the signal. Then follows a diode pump consisting of diodes D1 & D2 which produces a DC voltage proportional to the standby current detected by T1. The voltage is monitored by pin 17, the ADC 0 input of IC3, a PICAXE18X1 microcontroller. ZD1, a 4.7 V zener diode, limits this voltage.

When the master device is turned on, it will draw more current than in its standby state and this is sensed by IC3 which then activates relay RLY1 and thus turns on the peripheral devices which are connected to the slave power point.

Since different master devices may have very different standby currents, the gain provided by IC1 must be matched to the standby current of the master device being used. This is where the "auto sensing" comes into play.

IC4 is a quad analog switch under the control of the PICAXE. With all analog switches off, the only feedback resistor for IC1 is 470kΩ which sets the maximum gain at 471. To achieve lower gains, other feedback resistors are switched in parallel by IC4 and this results in gains of approximately 100, 50, 5 and 2.5 (The on-resistance of IC4 becomes significant in the last case.)

The software in IC3 selects the most appropriate gain to use via outputs 0-3 and transistors Q2-Q5. Q1 is used to rapidly discharge the 100µF capacitor at the output of the diode pump, when necessary. This ability to automatically adjust for the master device is what separates this device from many others where the sensitivity has to be manually adjusted to suit each master device.

Additionally, the software also monitors the standby and on currents for small changes and adjusts the threshold for switching on or off accordingly.

T1 and T2 are two line voltage filters salvaged from old computer power supplies. They essentially consist of two windings of about 50 turns each of 1mm enamelled copper wire wound on a powdered iron toroid. In its original use, one coil is placed in the Active line and the other in the Neutral line to serve as a filter. This is exactly the function of T2. It was found necessary to provide a high degree of filtering for the PICAXE18X1 as it was prone to resetting itself when the master device was switched off.

Jack Holliday is this month's winner of a Peak Atlas Test Instrument

T1 uses the filter as a 1:1 isolating transformer. In this case the powdered iron core needs to be cut between the primary and secondary winding to provide an air gap. This was found to be necessary as the iron core tended to saturate with higher current levels.

In use, if the device is switched on (or reset) and the master device in standby mode is plugged in, the PICAXE goes through an initialisation routine whereby it sets the gain to an appropriate level. Yellow LED1 is lit during this process. When the unit is ready, LED1 is extinguished and green LED2 is lit. The unit is then ready for use.

When the master device is turned on, power will be delivered to the slave outlet and red LED3 will light as well as LED2. When the master is switched back to standby, power is removed from the slave outlet and LED3 is extinguished.

Jack Holliday,
Nathan, Qld.

Note 1: the software (Powerboard.bas) can be downloaded from the Silicon Chip website.

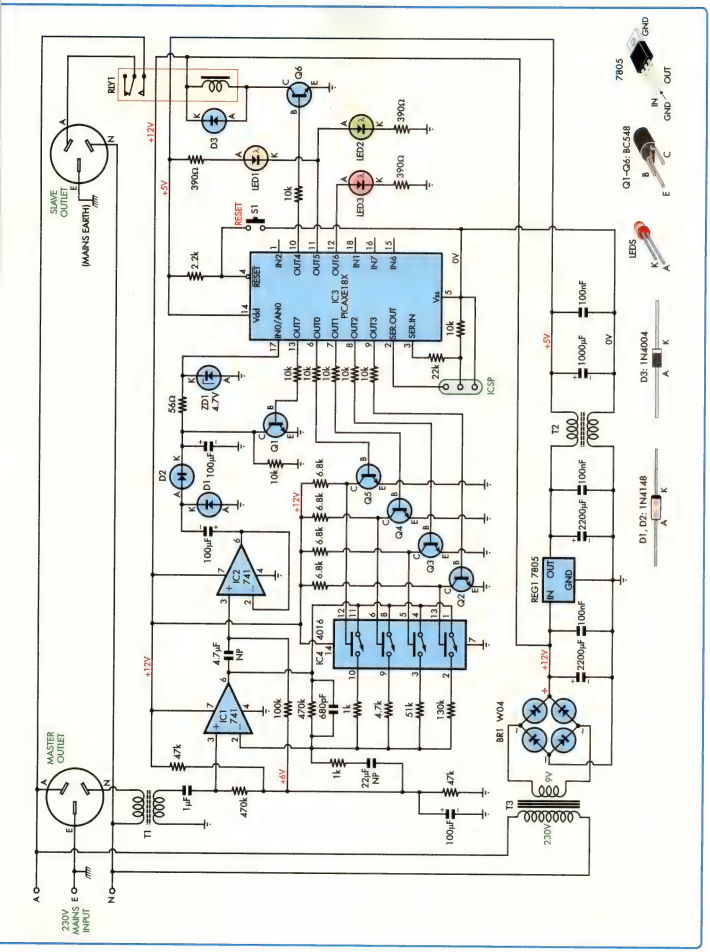
Note 2: do not build this device unless you know what you are doing.

Contribute And Choose Your Prize

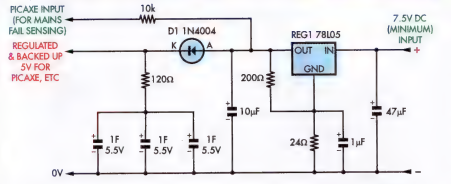
As you can see, we pay good money for each of the "Circuit Notebook" items published in Silicon Chip. But now there are four more reasons to send in your circuit idea. Each month, at the discretion of the editor, the best contribution published will entitle the author to choose the prize: an LCR40 LCR meter, a DCA55 Semiconductor Component Analyser, an ESR60 Equivalent Series Resistance Analyser or an SCR100 Thyristor & Triac Analyser, with the compliments of Peak Electronic Design Ltd www.peakelec.co.uk

So now you have even more reasons to send that brilliant circuit in. Send it to Silicon Chip and you could be a winner.

You can either email your idea to silicon@siliconchip.com.au or post it to PO Box 139, Collaroy, NSW 2097.



SLAVE OUTLET
(MAINS EARTH)
MASTER OUTLET
230V MAINS INPUT
RLY1
+12V
+5V
+6V
RESET
S1
IC3 PICAXE18X
IC2 741
IC1 741
IC4 4016
REG1 7805
BR1 W04
T1
T2
T3
230V
9V
ICSP
LED1
LED2
LED3
Q1
Q2
Q3
Q4
Q5
Q6
D1
D2
D3
ZD1
4.7V
56Ω
100µF
6.8k
4.7µF NP
100k
470k
680pF
1k
4.7k
51k
130k
47k
1µF
470k
22µF NP
100µF
10k
2.2k
390Ω
22k
100nF
1000µF
2200µF
7805
GND
IN
OUT
Q1–Q6: BC548
LEDS
D3: 1N4004
D1, D2: 1N4148



PICAXE supply uses supercaps for backup

While most backup supplies rely on batteries, this novel circuit uses supercaps. It is intended for use with PICAXE microcontrollers which run with a 5V supply but could be employed in any circuit where data or settings need to be preserved when it is powered down. It could easily be incorporated into the supply arrangement for any micro.

The circuit is based on a 78L05 low-power 3-terminal 5V regulator but could use a 7805 if its higher current drain is not an issue. The 5V regulator powers the micro circuit as well as charging three 1 Farad supercaps via a 120Ω resistor. The resistor is included to prevent the capacitor bank from being seen as a momentary short circuit at turn on, while providing a low impedance to the PICAXE circuit which usually draws only microamps or a few milliamps.

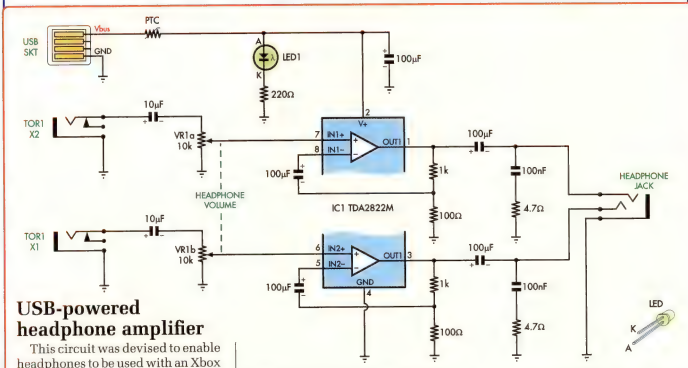
Note that high currents are available from the capacitor bank for a short time when fully charged so the 120Ω resistor is a safety feature.

The output of REG1 is increased to about 5.8V by the two resistors connected to the OUT and GND terminals. This has been done to compensate for the voltage drop across diode D1 which has been included to isolate the supercaps from the regulator when the input supply is removed.

The 10kΩ resistor from the output of the regulator can provide a "Power Fail" flag signal to the micro and an orderly shut-down may then be performed. This might include writing registers (W0-W6) to EEPROM, closing a process down elegantly and even maybe announcing power is lost. A "help me" call may be as simple as a piezo beeping to alert you that the plugpack has just been unplugged from the wall. Alternatively, the micro could be put to sleep.

The 1F 5.5V capacitors are available from Jaycar Electronics, Cat RU-6705. In circuit, the supercaps behave like batteries in that they take some time to charge. In this particular circuit, the supercaps took over 20 minutes to charge. Their discharge time depends on the load current which should only be a few milliamps or less.

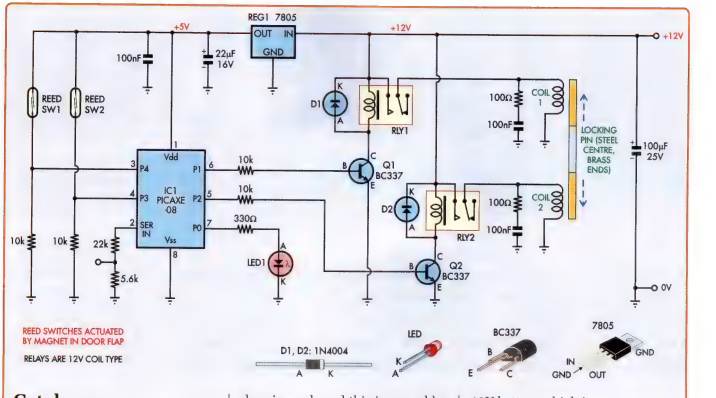
Brett Cupitt,
Ashfield, NSW. ($40)



USB-powered headphone amplifier

This circuit was devised to enable headphones to be used with an Xbox without requiring an additional plugpack power supply. It employs the TDA2822M dual power amplifier which can run off low voltage supply rails. This makes it suitable to be run directly from a 5V rail from a USB socket. The external negative feedback sets the gain to about 10.

A volume control is provided by dual-ganged 10kΩ potentiometer VR1 or this could be substituted with two 10kΩ trimpots. A LED in



Cat door control

This cat door control was devised to overcome a problem with stray cats following our cat home and subsequently stealing its food. In essence, it allows the home cat to go outside and then come back in, after which the cat door is disabled. It works as follows. The flap door is fitted with a magnet which can close one of two reed switches, depending on whether the cat is entering or leaving.

The reed switches are sensed by the PICAXE microcontroller and it activates one of two relays. When the cat leaves, a sliding hasp (bolt) is pulled back by solenoid coil 1 which is energised by relay RLY1. This allows the cat to come back in.

When it does so, it pushes the flap door inwards and this is sensed by the second reed switch. The PICAXE then activates relay RLY2 which energises solenoid coil 2 to pull the sliding hasp back into the locked position, after the cat door has moved back to its closed position.

This prevents any stray cats from following the home cat back in and then eating its food. In practice this works well, although in theory, it does nothing to stop a stray cat from entering once the home cat is outside.

The sliding hasp is 6mm in diameter and has a centre section of steel with 22mm threads at each end to take screw-on brass sections. The brass sections have rubber sleeves acting as stops to stop the hasp from sliding right through the coil former.

The plastic coil former is 38mm wide and 30mm in diameter. The two coils are wound onto the former, one above the other, with 300 turns each of 0.65mm enamelled copper wire. This was salvaged from a dismantled microwave oven transformer.

The circuit draws about 20mA on standby and around 70mA when the relays are energised. To this must be added the peak current of about 5A, drawn by the solenoid coils when they are briefly activated. The circuit will need to powered by a 12V battery which is on permanent trickle charge.

Nigel Quicke & Keith Kendrick, via email. ($45)

Note the software is listed below and is also on the SILICON CHIP website.

series with a 220Ω current-limiting resistor is used for power indication.

Note that the 100µF capacitors will cause some restriction of the bass response, depending on the impedance of the headphones but where small component size is desirable, this is a reasonable compromise.

The TDA2822M is available from **www.futurlec.com**

Rodney Hedger, Oakleigh, Vic. ($35)

Program Listing: Cat Door Control

```
main:
        if pin3 = 1 then open
        if pin4 = 1 then lock
        goto main


open:
        high 0          'switch pin 0 on (indicator led)
        wait 10         'delay
        low 0           'switch 0 off (indicator led)
        pause 10        'pause between the switch off and on
        high 2          'turn pin 2 on (activate open coil)
        pause 500       'pause .05 of a second
        low 2           'turn pin 2 off (deactivate open coil)
        goto main       'return to start of program

lock:
        high 0          'switch pin 0 on (indicator led)
        wait 10         'delay
        low 0           'switch 0 off (indicator led)
        pause 10        'pause between the switch off and on
        high 1          'turn pin 1 on (activate lock coil)
        pause 500       'pause .05 of a second
        low 1           'turn pin one off (deactivate lock coil)
        goto main
```

Designing and Installing a HEARING LOOP For the deaf

Part 2: By JOHN CLARKE

Last month we introduced the subject of hearing aid inductive loops and explained how they were designed. We also mentioned that most amplifiers could be used to drive hearing loops, albeit with a bit of tweaking in most cases. Now we move on to some of the commercial equipment designed specifically for driving hearing loops.

As we explained last month, the vast majority of build-it-yourself and commercial (hi fi and PA) amplifiers are voltage amplifiers, whereas hearing loop amplifiers are current-operated devices. That's not to say you can't use a voltage amplifier on a hearing loop – you can, with appropriate treble boost to compensate for rolloff in signal strength due to loop inductance.

But typical amplifier treble controls are not suitable because they do not operate at the correct frequency. There is a better way, and that is to "pre-condition" the audio feed to the amplifier – and we'll shortly be describing such a device. It's quite simple and relatively cheap (especially if that means you don't have to buy a new hearing loop amplifier).

This month we're going to look at some of the commercial hearing loop amplifiers often found in public buildings. These are the ones often installed by professional organisations who are these days fitting out most new buildings and retro-fitting olders ones, as we also explained last month.

Auditec hearing loop amplifiers

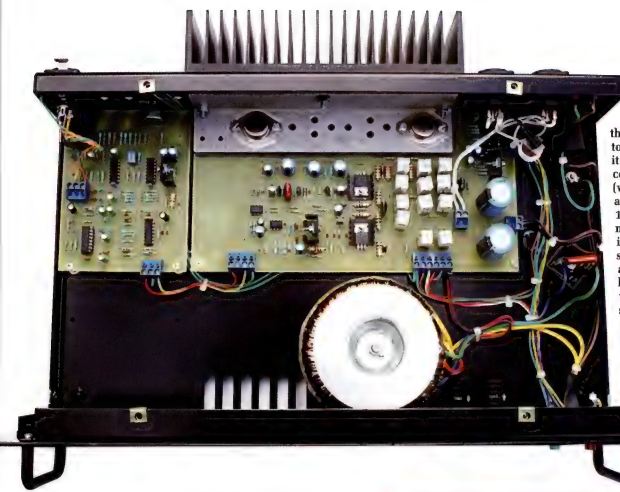
The Auditec (www.auditec.com.au) range of hearing loop amplifiers is an example of what is available commercially. This Australian company designs and manufactured its range locally and offer a five year warranty. The Auditec 1077 amplifier shown here is in a 2-unit rack mount case. Lower powered amplifiers are built into a smaller instrument-style case.

They are available from Bavas Music City, (www.bavasmusic.com.au), Delsound, (www.delsound.com.au) and Moore Hearing, (www.moorehearing.com.au).

The amplifiers include signal compression (to maintain a more constant signal level), a bargraph loop level display, and loop disconnect indicators. Frequency response of the amplifiers is from 100Hz to 5kHz. The table below shows the amplifiers that are available and the size of the loop that each amplifier can drive.

The 1077 amplifier for example can drive a loop that has a maximum perimeter of 150m. This equates to a maximum loop size of 15 x 60m or 20 x 55m or similar but note that the smaller dimension must not exceed 20m. So you cannot use a 37.5m square loop. Minimum loop size is 10 x 10m and that equals the minimum loop perimeter of 40m. The wire used is 2 x 24/0.2mm figure-8 wire connected in series to form an effective two turns around the loop.

Auditec's model 1077 transconductance amplifier (another way of saying current amplifier!) designed specifically for hearing loop use. It can drive a loop between 40m and 150m long.



Auditec's model 1077 – at first glance, there is not much to distinguish it from a conventional (voltage) PA amplifier. The 1088 and 1099 models also include a separate 10W amplifier for loop monitoring via a local speaker. The table below shows various loop sizes and lengths for Auditec hearing loop amplifiers.

Each amplifier includes the bargraph level display to enable the loop level to be set correctly. The level is set so that the orange LED just lights on loud levels but without the red LED lighting. It appears that the amplifier displays the signal level based on the total resistance of the loop and that the listening height above the loop is assumed to be in the seated position above a floor mounted loop.

As explained last month, loop power is dependent upon loop size and height above the loop to produce the necessary field level. You may require a lower loop current if the length of wire used for the loop does not make up the total length. So, for example, if you have a loop that is 10m x 10m but the total wire length is not 40m as you would expect for a 10 x 10m square loop but is, say, 60m. This extra wire length is used to reach the amplifier that is not located nearby the loop. For this setup, the signal level display may differ from the true level.

Model	Power (VA)	Maximum total loop length (m)	Minimum total loop length (m)	Maximum width across the narrow side (m)
1044	20	40	20	5
1055	60	80	20	15
1077	120	150	40	20
1088	120	150	40	20
1099	300	400	40	30

Ideally for any hearing loop setup, the field strength should be monitored using a field strength meter to ensure

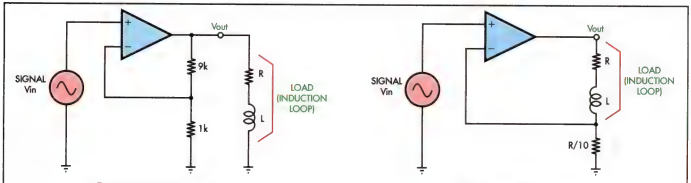


Fig.15a (left): repeated from last issue, a voltage amplifier driving a hearing aid loop load will produce less current in the loop with rising load impedance. Fig.15b (right) : a current amplifier driving a hearing aid loop load will maintain current in the loop with rising loop impedance.

Last month we described a build-it-yourself hearing loop receiver but if you aren't inclined to build your own, here's a commercially available receiver for use with headphones (available from Moore Hearing, www.moorehearing.com.au). Even if you don't have a hearing loss, a hearing loop receiver is handy when you're setting up the loop, to monitor for sound quality without the need for assistance from a person with a T-coil-fitted hearing aid.

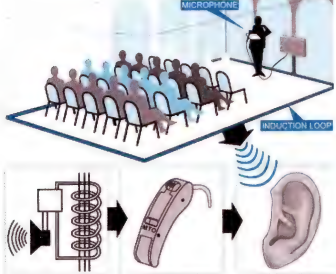
the level is correct. We will be publishing a suitable level meter in a future issue.

You may require a higher powered amplifier if the height above (or below) the loop is significant compared to the loop size. More detail about extra power requirements for height above or below the loop is in the Voltage amplifier section (see last month's article).

Voltage and current amplifiers

Fig.15a shows the configuration of a voltage amplifier with a gain of 10. It is based around a high gain amplifier with negative feedback between the output and inverting input. The output voltage is divided by 1kΩ/(1kΩ +9kΩ) and so overall the division is by 10. This divided signal is applied to the inverting input and output is adjusted so that the inverting input is at the same voltage as the non-inverting (+) input. Gain of the overall signal from input to output is 10. Gain can also be calculated by the equation 1+ (9k/1k). The output drives the load between V_{OUT} and ground. Voltage output is independent of the amplifier load assuming the amplifier can drive the load.

If this amplifier drives a hearing loop, then for a fixed signal level, the current through the hearing loop will vary with the load impedance. Since the load comprises a resistance and an inductance, the effect of the inductance will be to increase load impedance with frequency. See the section 'Inductance of the loop' for more detail. The current through the loop will therefore fall with increasing frequency.



For example if the overall load impedance doubles to become 2R, the load current will be halved compared to if the load is just R. To maintain a constant current in the load with rising load impedance, the applied input signal needs to rise with frequency.

With the current amplifier configuration shown in Fig.15b, the load is a part of the feedback network. At low frequencies, the impedance of the load is just the resistance [R] and so the division of the output voltage applied to the inverting input is (R/10)/(R +R/10). Gain between the input and output is therefore 11.

Note, however, that the signal across the load is less than the full V_{OUT}. This is because the load is not between V_{OUT} and ground but is via the R/10 resistance. Therefore

A practical PA system incorporating a hearing loop. This church setup consists of a Redback (Altronics) diversity UHF wireless microphone receiver, a foldback amplifier sitting on top of the Auditec hearing loop amplifier, while underneath are two 120W front-of-house amplifiers with a small audio patch box just visible on top of them.

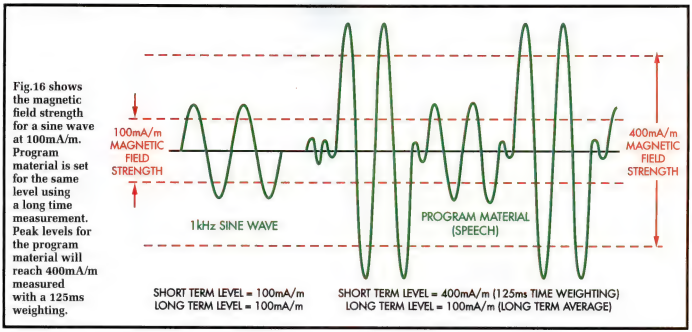


Fig.16 shows the magnetic field strength for a sine wave at 100mA/m. Program material is set for the same level using a long time measurement. Peak levels for the program material will reach 400mA/m measured with a 125ms weighting.

only 10/11ths of the signal at Vout is across the load. The remaining $1/11^{th}$ of the signal is across the R/10 resistor and this represents a small power loss. Overall gain as far as the load is concerned is therefore 10, the same as the voltage amplifier.

Another way of looking at this is to note is that the voltage signal at the input (V_{IN}) will be the same as the voltage across the R/10 resistor. When the load is just R at low frequencies, the signal through R is 10 times the Vin signal.

Because the load impedance is a part of the feedback for the amplifier, any changes in the load impedance will alter the gain. So for example, if the overall load impedance is doubled to become 2R, amplifier output is V_{IN} x (2R +R/10)/R/10 and that simplifies to 21. Signal across the load is 20 times the input (2R/R/10).

Therefore the voltage across the load doubles when the load resistance doubles. This maintains a constant load current regardless of the load impedance. So a current amplifier automatically increases voltage across the load as the load impedance increases.

With any amplifier the output must be able to maintain the voltage swing required to provide the gain of the amplifier. This depends on the power and voltage swing available from the amplifier.

Ampetronic design guide

As mentioned last month, details on suitable loop designs with steel buildings can be obtained from Ampetronic (www.ampetronic.com). They provide a design guide for induction loops that includes information on spill control and loop arrays. The image at left is taken from this guide.

One thing to note is that this design guide **misinterprets** the field strength requirement for the hearing loop. The Ampetronic design guide incorrectly states that: "*the magnetic field strength must be 400mA/m ±3dB across the volume of use. This is the reading with 125ms RMS measurement with a 1kHz sine wave applied to the system.*"

The standards specifically state that the field strength should be 100mA/m (within 3dB) as created by a 1kHz sinusoidal signal. It is only with normal program material (such as in speech) where the 400mA/m level will be reached and this is during peaks in level using a time-weighted measurement of 125ms. Long time measurement of the program material should equal the sine wave level. For more detail see the section below headed 'Hearing Loop Standard'.

Setting the long time average field strength level to 400mA/m may provide better results in induction loop receivers because the signal to noise level is improved by 12dB. However, this is not the standard level and at this level it is likely to cause a hearing aid to overload particularly during signal peaks.

Hearing loop standard

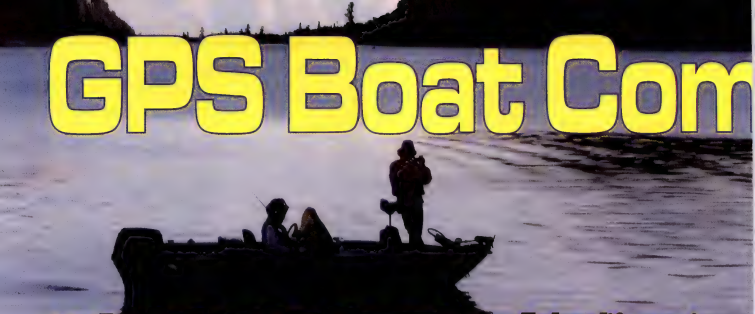
The hearing loop and designs in this article conform to the current specifications for Hearing Aids titled: Magnetic field strength in audio frequency induction loops for hearing aid purposes. Details are available in European standard IEC 60118-4 Ed. 1.0 (1981) and the Australian and New Zealand standard AS60118.4-2007. Both European and Australian/NZ standards have the same specifications.

Hearing loop magnetic field strength levels are recommended to be at 100mA/m. This is for a 1kHz sine wave signal. The level for program material when measured over a long time period should equal this sine wave level. The program material is expected to vary by 12dB in level using a 125ms time weighting. Measured peaks will therefore rise to 400mA/m. The same 125ms time weighting for the sinewave signal will remain at 100mA/m.

Fig.16 shows the magnetic field strength for a sine wave at 100mA/m. Program material is set for the same sine wave level using a long time measurement. Peak levels measured with a 125ms weighting will reach 400mA/m. Note that the sinewave level will remain at 100mA/m with either time weighting measurement over 125ms or long time.

Values for maximum background environmental field strength and loop frequency response are also provided in the AS60118.4-2007 standard. Standards are available from SAI Global at http://infostore.saiglobal.com/store/ SC

GPS Boat Com



For all the boaties out there, this one could literally be a life saver! You'll never be lost again: as well as telling you exactly where you are at the moment, it will also show you your speed and heading and can even navigate you back to your starting point – or to that secret fishing spot! It can even tell you how much fuel you're using, along with a host of other vital information.

Back in January of this year we described the GPS Car Computer, a project that used a low cost GPS module to provide a variety of data for the motorist.

The project essentially consisted of a microcontroller, a display and a GPS module and it was obvious from the outset that it could be used for other applications.

One reader, Nigel Hall of Dee Why in Sydney (himself an avid boatie!), was quick with the suggestion that we should make a nautical version. Nigel then went on to put in a lot of his time into defining a typical set of boating requirements and testing the final product.

So here is the result – the GPS Boat Computer, a small electronic device intended to provide the weekend boater with a host of useful information.

It will show your speed in knots, your heading, fuel consumption rate and the total amount of fuel consumed. It will also show your latitude and longitude and a compass needle pointing north.

Possibly the most handy feature is the ability of the GPS Boat Computer to memorise up to eight of your favourite fishing or diving spots and later guide you back to the exact same spot – even if it is in the middle of the ocean.

The hardware

This project illustrates a trend in modern electronics... the use of intelligent and general function devices that can be reprogrammed to suit a variety of purposes.

An extreme example of this are the Mars rovers Spirit and Opportunity. They have been reprogrammed many times to cope with the various conditions and terrain that they have met during their exploration of the red planet.

In a similar vein the GPS Boat Computer uses virtually the same hardware and circuitry as the GPS Car Computer described in January and February 2010. The major difference is in the firmware which completely changes the character of the device.

You do not need a PIC programmer for this change in personality; the new firmware can be loaded via USB from your computer and the Car Computer will become the GPS Boat Computer.

You could, if you wished, then load the Car Computer firmware (also via USB) and flip back to that personality. In fact, you could drive to the marina with your GPS Car Computer, load the new firmware (it only takes 20 seconds) and sail off with your GPS Boat Computer!

This also means that if you want to build this project from a kit you can simply buy and build the kit of parts for the GPS Car Computer (from Altronics) and upload the new firmware to turn it into a GPS Boat Computer.

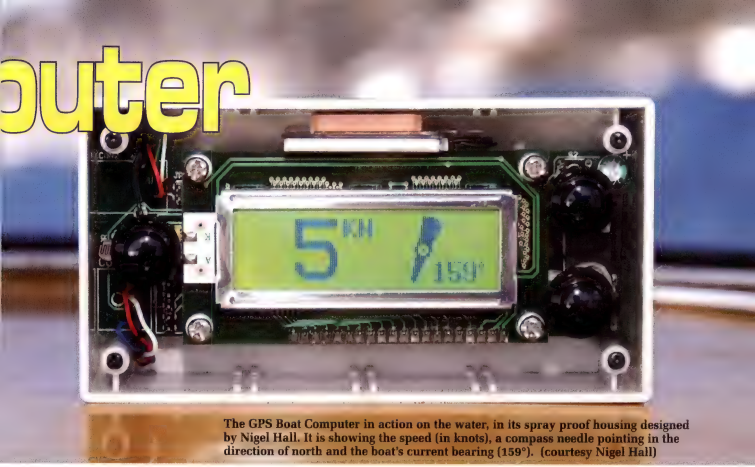
The only thing that you might need to do is consider a different enclosure – and we will talk about that shortly.

Using the GPS Boat Computer

The GPS Boat Computer is quite easy to use. You have a number of screens that show useful information which you select by pressing the UP or DOWN buttons. These buttons will wrap around the available set of screens when you have reached the end. When you turn the GPS Boat Computer off it will remember the last screen and will automatically return to that when power is reapplied.

All screens have something that can be configured or changed. For example, when the clock screen is showing you can set the time zone. To change a setting you press the SET button

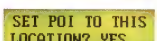
by Geoff Graham



The GPS Boat Computer in action on the water, in its spray proof housing designed by Nigel Hall. It is showing the speed (in knots), a compass needle pointing in the direction of north and the boat's current bearing (159°). (courtesy Nigel Hall)

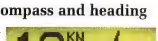
and then use the UP/DOWN buttons to adjust the value. Pressing the SET button a second time will save the value and either take you to another option or return to the main display.

Options



Some options are in the form of a question. The screen above shows a typical example of this and when presented with this you select YES or NO by pressing the UP/DOWN buttons then press the SET button to confirm the selection.

Speed, compass and heading

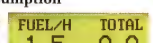


When you start up the GPS Boat Computer for the very first time the screen that you will see is shown above. This displays your speed in knots, a compass needle pointing north and your heading in degrees. The speed is averaged over a few seconds and is reasonably accurate, even down to one or two knots.

The compass and heading are both derived from the change in latitude and longitude as your boat moves through the water. So if the boat is stationary, both of these will be blanked to prevent them showing random and incorrect values.

Pressing SET will enable you to switch the display to reverse video (green lettering on a black background). This might help in situations of poor visibility caused by bright sunlight.

Fuel consumption



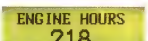
Pressing the DOWN button will take you to the next screen. This shows your current rate of fuel consumption and the total fuel consumed. This data is dependent on the installation of the optional fuel flow sensor (described later).

The instantaneous reading (litres/hour or gallons/hour) can be used to adjust the speed of the engine for an optimal cruising efficiency. To reduce jitter in the display the reading is averaged over several seconds.

The total fuel consumption can be used to estimate the amount of fuel remaining in your tank. You would normally reset the total to zero when you fill the tank and this can be done by pressing the SET button and using the UP/DOWN buttons to select YES at the prompt.

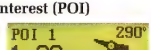
By pressing SET you can also calibrate the amount of fuel consumed. The way to do this is quite straightforward. Fill the tank, zero the total and take your boat for a run. When you return, refill the tank to the same level and use the calibration screen and the UP/DOWN buttons to set the actual amount of fuel consumed. If you enter the amount consumed in litres then all readings will be in litres, similarly if you use gallons then all readings will be in gallons.

Engine run time



The next screen is the engine run time shown above. This is mostly used to determine when engine maintenance is due. It is assumed that when +12V is present on pin 2 of the 6 pin connector that the engine is running, so this pin would normally be connected to the ignition circuit of the engine.

Point Of Interest (POI)



This powerful feature will memorise your

current location and later guide you back to within a few metres of the same spot. This is great for returning to your favourite fishing spot, dive location etc. To set a POI to the current location you simply press SET when on a POI screen then select YES when prompted.

The POI screen illustrated will show your distance to the location while the needle and number will show the bearing that you should take.

To return to a location you just follow the needle and watch the distance count down. As you get closer the distance display will switch to metres with a resolution of one metre.

Because the Earth's surface is spherical, accurate calculation of the heading and distance would require the use of spherical trigonometry and 64 bit floating point numbers... something that is just not possible for our overloaded microcontroller.

So we cheated and pretended that the earth was flat and used simple trigonometry and Pythagoras' Theorem instead.

The result is that from a distance the heading/distance will be a little inaccurate but, as you get closer, the accuracy will improve considerably. Depending on the signal level and other factors the GPS Boat Computer will direct you to within a few metres of the exact location – and that is pretty good when you are looking for a spot in the middle of the ocean.

The GPS Boat Computer will memorise up to eight points of interest and these are shown in sequence when you press the UP or DOWN buttons. To reduce the number of screens that you have to step through, only the first three are shown by default.

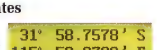
However, it is easy to enable the other POI screens using the Hide/Show function (see below for a description of this function).

You can also use points of interest as waypoints. To do this simply set them in sequence (ie, POI #1, POI #2, etc). When you reach one of them pressing the DOWN button will show you the next. This way it would be easy to run from one waypoint to the next.

By pressing SET and selecting the appropriate option you can also clear a POI and that screen will not show any directional data when you step through it with the UP/DOWN buttons.

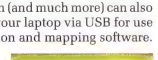
One facility that would have been really handy would have been the ability to manually enter the coordinates of a POI. Unfortunately the microcontroller just did not have enough program space for this function, so we reluctantly had to leave it out.

Coordinates



The latitude and longitude screen displays your current location in degrees, minutes and fraction of a minute. This information (and much more) can also be sent to your laptop via USB for use by navigation and mapping software.

Signal level



The signal level screen shows how many satellites should be in the sky (the number in the top left) and the number that are currently being used by the GPS module (bottom left). The bar graph shows the signal level of every satellite that can be detected but the module may not use every one if some of the levels are too low.

When you are on the signal level screen you can adjust the backlight brightness for day and night conditions by pressing the SET button.

Clock

The last screen displays the current time in 12 hour (AM/PM) format with the seconds shown on the bottom right. The time is derived from the GPS signal and is accurate to within 100ms. Pressing the Set button will allow adjustment of the time in steps of half an hour (ie, this sets the time zone – the exact time is always derived from the GPS satellites).

Special Functions

The GPS Boat Computer has a couple of special functions that make it easier to handle the various screens that can be displayed.

The first function is Auto Scan mode where the display will automatically flip from one screen to the next every three seconds. When it reaches the end it will wrap around and continue on from the top. When your hands are full this is far easier than pressing the UP or DOWN buttons to show a new screen.

To enter Auto Scan mode you should simultaneously press both the UP and DOWN buttons. To exit this mode press any single button.

You may not want to see all the screens as you cycle through them so you can configure the unit to hide some of them.

To set this up you must hold down the UP button when you apply power. This will put the unit into a mode where you can set the following characteristics for each screen:

- Show.
- Hide in auto scan.
- Always hide.

When set to "Always hide" that screen will be skipped as if it did not exist. The "Hide in auto scan" setting is useful if you want to hide some screens during the Auto Scan mode but still have them available when you manually step through the screens. A good example is the Engine Running Time screen which you do not need to see while in Auto Scan.

While configuring the Show/Hide function the SET button will step you through the three settings described above and the UP and DOWN buttons will move you through the list of screens available for configuration.

To exit this mode you simply re-

The EM-408 GPS receiver module used in this project (and of course in the GPS car computer from last January). It is available as part of the kit from Altronics (as mentioned earlier, the GPS Car Computer can become the GPS Boat Computer), as a separate item from Altronics or from a number of sources on the internet. Other modules *might* work; we know this one does!

move and reapply the power.

Measuring Fuel Flow

One of the features of the GPS Boat Computer is its ability to measure the amount of fuel consumed by the engine in litres or gallons per hour and as a total. This function is optional so you can ignore this section if you wish to.

There are two choices when it comes to measuring fuel consumption. If your engine is diesel or fuel-injected you can measure the length of time that the fuel injectors are open. This is the same technique as used in the GPS Car Computer and only requires a connection to the fuel injector solenoid.

The voltage on the solenoid lead is normally high and it is pulled low by the engine management unit to open the solenoid and inject fuel into the cylinder. Normally the pressure in the fuel line is reasonably constant and therefore the time that the solenoid is open directly corresponds to the amount of fuel consumed.

If you have a carburetted engine then the alternative is to use a paddle wheel flow sensor. These have a miniature paddle wheel or small turbine which is rotated by the flow, magnets attached to the rotating shaft will then cause a reed switch or a Hall Effect sensor to switch on as the magnet swings past. As a result we get a series of pulses at the output, the faster the pulse rate, the faster the flow.

Paddle wheel flow sensors are easy to find but it is much harder to find one that is suitable for use with fuel. This is because the O-rings in a normal flow sensor will perish in contact with fuel and will eventually leak – which is a very dangerous situation in any boat.

So, if you decide to use a flow sensor, check the specifications and only use one that specifically states that it is suitable for use with petrol or diesel fuel. Also be aware that some O-rings may be specified as OK with ordinary (unleaded) petrol but may not be so with petrol with ethanol additives.

We bought ours via eBay but this particular product has since disappeared from their listings. RS Components (australia.rs-online.com) have a suitable but expensive sensor (part no. 508-2704).

A similar sensor is branded MGL Avionics and is available from www.lightflying.com.au or oregonlightsport.com and other online suppliers. It is intended for experimental aircraft but is also suitable for our application.

The paddle wheel fuel flow sensor that we purchased on eBay. It has three connecting wires – one for ground, one for +12V power and one for the signal output. The output is open collector so we soldered a 3.3kΩ resistor between the signal lead and +12V. This could be squeezed inside the 6-pin plug if there is enough space. (Courtesy Nigel Hall)

The GPS Boat Computer itself can be calibrated over a wide range so it should work with almost any flow sensor that has a pulse output. You might also find a number of paddle wheel sensors designed for marine applications that provide a NMEA 2000 output in place of the simple pulse output. NMEA 2000 is a complex marine communications protocol and regrettably beyond the capabilities of the microcontroller in the GPS Boat Computer.

Two different versions of the firmware are available from the SILICON CHIP website, one for flow sensor measurement and the other for fuel injector measurement.

The file names are:

- GPS Boat Computer V1.0A Update.hex – will use the paddle wheel flow sensor.
- GPS Boat Computer V1.0B Update.hex – will use the fuel injector monitoring method.

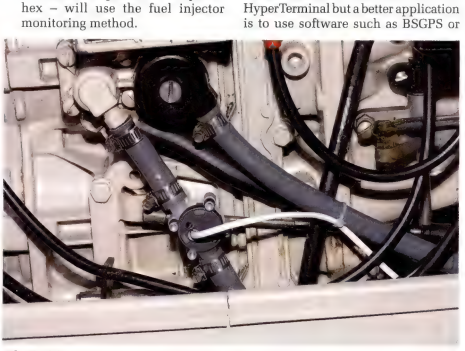
Both are easily loaded via USB from your computer and you can experiment by switching between them if you wish.

If you do not want to use the fuel consumption feature you can load either version of the firmware and ignore the fuel consumption screen or hide it by using the Show/Hide function described earlier.

USB Interface

The GPS Boat Computer is equipped with a USB interface that can be used with a laptop computer for displaying your location on electronic maps, recording you track and similar tasks. Essentially, when the microcontroller receives some data from the GPS module, it will also send a copy to your laptop using a virtual serial connection over USB.

You can see the data stream by using a serial emulator such as PuTTY or HyperTerminal but a better application is to use software such as BSGPS or



The fuel flow sensor mounted in the fuel line of a Chrysler outboard as recommended by the manufacturer, ie, vertically between the fuel pump and the carburettor. (Courtesy Nigel Hall)

OziExplorer to display your position on an electronic map (use Google to search for any of these names).

This type of software can use scanned copies of your charts and pinpoint your position on them.

If you search on the Internet you will find a wealth of other software that will allow you to navigate, log your movements, play with the GPS Module and much more. You can also check www.maps-gps-info.com/fgpfw.html where almost 500 free GPS-related programs are listed.

To use this feature you need to install the Silicon Chip USB Serial Port Driver on your laptop (available from the SILICON CHIP website). This will work with all modern versions of Windows and full instructions are included with the driver, so installation should be easy.

The GPS Boat Computer will be listed on your laptop in the Device Manager under Ports (COM and LPT) as "Communications Port – Silicon Chip USB Serial Port" with a specific COM port number. When you configure software on your computer you will need to specify this number to establish communications with the GPS Boat Computer. If the software also needs to know the communications parameters you can specify 9600 baud with one stop bit and no parity.

When using USB you should make sure that there is not a jumper on the pins marked JP1. This jumper is intended for when you want to only power the GPS Boat Computer via a USB cable connected to your laptop. However, in most cases the GPS Boat

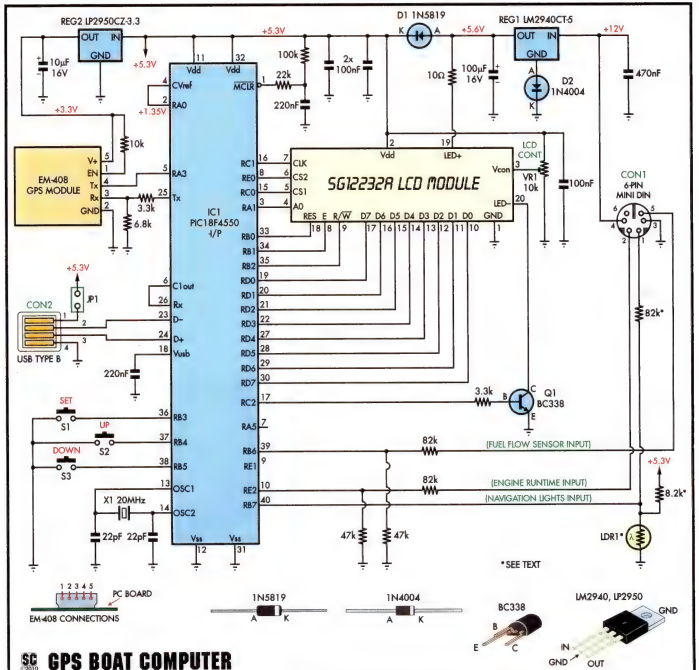


Fig 1. The full schematic for the GPS Boat Computer. It is dominated by the microcontroller which is mostly concerned with receiving data from the GPS module and driving the LCD. The other items of note are the GPS module and the two voltage regulators which provide 5.3V and 3.3V.

The USB interface connects to CON2 on the PC board. Normally a board-mounting socket fits here but it this case we need it to be waterproof so it's off the board. (Courtesy Nigel Hall).

Computer will be permanently connected to the boat's battery and so you should not install the jumper. Doing this would cause 5.3V to appear on the USB connector and possibly damage your laptop.

Circuit Details

Fig 1 shows the circuit diagram for the GPS Boat Computer. It is identical to the GPS Car Computer with the addition of a couple of resistors (in spare locations on the PC board) and so it uses the same PC board and components.

The circuit is dominated by the PIC18F4550 microcontroller, a modern eight bit device manufactured by Microchip. This has a number of features that are important to us.

Firstly it has plenty of input/output pins as we need them to drive the graphics LCD module. This module uses eight signal lines for data and another 7 control lines, making for a total of 15 pins that the micro needs to manage the display.

The LCD module is a graphical device which means that we can turn off and on any pixel in its 122 by 32 pixels array. We use this capability to show a variety of fonts ranging from large digits for good readability, to small letters when space is restricted. We also display some graphic symbols like a compass pointer.

The microcontroller also has full USB functionality built in and we can simply connect the USB signal lines direct to the chip. As described before, this allows us to send GPS data to a laptop which can then use additional software and maps to track our position.

The GPS module sends and receives data to/from the microcontroller using a standard 4800 baud, 8-bit serial protocol with voltage levels of about 2.7V for a logic high and zero for a logic low.

The 18F4550 microcontroller needs a voltage higher than 2.7V to reliably detect a logical high. So we first feed the data from the GPS module through an analog comparator (in the 18F4550) to obtain voltage levels that can be used by the micro. The GPS Car Computer article in January 2010 provides more detail of how this works.

Sending data to the GPS module is a little simpler. The 3.3kΩ and 6.8kΩ resistors form a voltage divider to drop the 5V transmit data signal from the microcontroller to a level compatible with the GPS module which runs at 3.3V.

The three front panel push buttons are connected directly to pins 36, 37 and 38 of the microcontroller. Internal pull-up resistors are used to hold the inputs at 5V and therefore

Why every boatie needs one of these: a true story!

Purely by co-incidence, as this feature was being prepared for publication one of the SILICON CHIP staff members, who owns a boat, was talking to a young acquaintance about boating in general.

The young man admitted that he had owned a boat previously but had sold it after getting the fright of his life, swearing off boating for good!

It transpired that he and some mates had taken the boat out fishing one moonless night on Pittwater, north of Sydney.

For those who don't know the area, it is a long, wide and relatively unpopulated waterway off Broken Bay, which itself is the very deep estuary leading to the mouth of the Hawkesbury River.

They'd been fishing for quite a while and in the early hours of the morning it dawned on them that they didn't have a clue where they were. They could have been anywhere between the southern end of Pittwater and some 20km away in the Hawkesbury itself. They didn't know whether the lights they could see (kilometres away) were the suburbs on the eastern side of Pittwater, those on the northern side of Broken Bay or, indeed, the towns on the Hawkesbury.

After driving around for some time trying (they didn't know how long) to get their bearings in the pitch black, running low on fuel, they also didn't know if they were headed upstream, back towards their launch site, or even straight out to sea (next stop, South America!) Compass? What was that?

With no light and little or no swell to listen to, they didn't know if they were close to any shore (almost all rocky) or thousands of metres from land. They were, quite literally, panicking – and as any authority will tell you, panic can kill!

Fortunately, they eventually spotted the lights of a larger boat at anchor and managed to wake the (rather unhappy!) skipper to ask for help.

The story had a happy ending – with directions, they managed to find the boat ramp around dawn – but it did prompt the very relieved owner to get rid of his boat!

Now, just think of how much easier their lives would have been if they had one of these GPS Boat Computers on board: not only would it tell them where they were, it would also navigate them back to their launching ramp and/or any other "way points" they entered.

And if they had happened to find that elusive, productive fishing spot (which they didn't!) next time they went out (which they didn't!), they could have navigated straight to it (which, of course, they didn't!).

We believe that a device such as this should be mandatory in every small craft – just in case. We believe that it's as essential as life jackets and flares. Larger boats, especially more recent ones, tend to have GPS navigation and computing "built in" but small boats, by and large, do not. Even a hand-held GPS would be better than nothing but this device gives you extra features that the hand-held units do not.

As our story shows, you don't have to head offshore to get yourself into trouble.

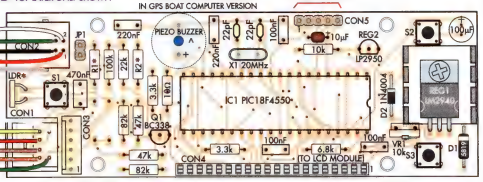
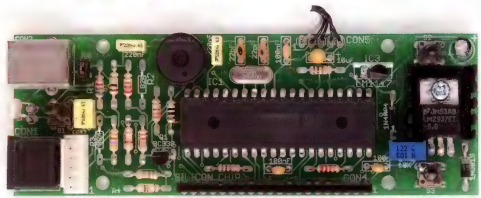


Fig.2: the PC board component overlay, along with the connections for CON1 and CON2. The options for LDR or Nav Light control (R1/R2/LDR) are shown in the table below.

	LDR	Navigation Light
*LDR	Install LDR	47kΩ resistor
*R1	8.2kΩ resistor	Leave Empty
*R2	Leave Empty	82kΩ resistor



The completed PC board. This prototype differs slightly from the final board, particularly around IC3 (REG2) and also the CON1 and CON2 connectors are shown here on the PC board. The board is compact but all components fit in with plenty of space.

when a button is pushed the microcontroller will detect this as an input dropping to 0V.

The remaining connections to the microcontroller are standard. The 220nF capacitor on pin 18 provides smoothing for the micro's internal 3.3V supply. A 20MHz crystal connected to pins 13 and 14 provide the main clock for the chip. Finally, the transistor Q1 connected to pin 17 is used to control the brightness of the LCD backlight by pulse width modulation (PWM).

The GPS Car Computer included a piezo buzzer for the over speed alarm but this is not used by the GPS Boat Computer firmware. We left it out of the circuit diagram and you do not need to install it if your device will always be operating as a GPS Boat Computer.

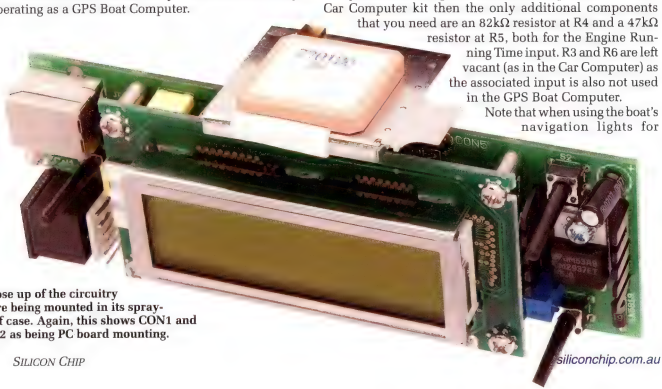
External Connections

All external connections are made through a 6 pin connector, CON1. 0V and 12V are on pins 3 and 4 of the connector and three other pins are used to monitor events in the boat.

Pin 5 is used for the fuel injector solenoid or paddle wheel flow sensor input. Pin 1 is used to detect when the boat's navigation lights are on (required if the LDR is not used) and Pin 2 is used to detect when the engine is running. All of these inputs use a voltage divider formed by 82kΩ and 47kΩ resistors to drop the input voltage to a level that is compatible with the microcontroller.

If you are building the GPS Boat Computer from a GPS Car Computer kit then the only additional components that you need are an 82kΩ resistor at R4 and a 47kΩ resistor at R5, both for the Engine Running Time input. R3 and R6 are left vacant (as in the Car Computer) as the associated input is also not used in the GPS Boat Computer.

Note that when using the boat's navigation lights for



A close up of the circuitry before being mounted in its spray-proof case. Again, this shows CON1 and CON2 as being PC board mounting.

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control a 47kΩ resistor is installed vertically in the position marked for the LDR and pin 1 on CON1 must be wired to the circuit powering the boat's lights.

The microcontroller determines if it is day or night by monitoring the voltage at pin 40. A high voltage means that it is night and low means day. By using the following table when you assemble the PC board you can tell the Boat Computer that it is day or night via a light dependent resistor (LDR) or the boat's navigation lights.

Construction

All the components are mounted on a single PC board which makes construction relatively easy. Fig.2 shows the component overlay – follow this diagram rather than that on any PC board, as some early PC boards had an incorrect screen print overlay.

The PC board is double-sided and uses plated-through holes so you need to take a little care with soldering. Use a temperature-controlled soldering iron and only hold the iron on a joint for a few seconds. With plated-through holes it is difficult to remove a component so be careful that you have selected the right component with the correct orientation before you apply the iron.

Start with the low profile components such as resistors and work your way up to the taller components such as the capacitors and transistor. Note that resistors R3 and R6 are marked on the PC board but not installed as they are reserved for future expansion. Don't install the microcontroller or the GPS and LCD modules just yet, as you need to check the power supply voltages first.

Be careful with D1 and D2 as they look alike. The same applies to Q1 (the transistor) and IC3 (the regulator), both are in TO-92 packages and can easily be confused.

When soldering in the crystal (X1) ensure that it sits a millimetre or two above the PCB so that there is no danger of the metal case shorting the connecting pads underneath.

The LM2940 regulator (IC2) sits on top of a small heatsink. Use a small amount of thermal grease between the regulator and the heatsink to ensure that the heatsink can do its job.

Before screwing down the regulator check that the heatsink does not touch the solder pads on either side of the heatsink. The spacing is very close here but the heatsink can be moved around to ensure that it has adequate clearance. Once this is correct you can tighten the screw and nut. Finally solder the regulator's leads – this is left to last so that the solder joint is not stressed.

The PC board has provision for an extra connector (CON3) which also can be seen in photographs of the prototype. Ignore this, as it is intended for use with a device like the

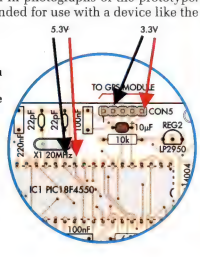

Fig 3. Before you plug in the microcontroller and connect the GPS module you should check that these voltages are present. Both have a tolerance of ±150mV. If you cannot measure the correct voltages you should check D1, D2, IC2, IC3 and the power connection.

Parts List – GPS Boat Computer

1 PC board, code 05101101, 140mm x 57mm
1 GlobalSat Technology EM-408 GPS module – available from Altronics (K1131) or via the 'net.
1 SG12232A 122 x 32 dot matrix LCD (Altronics Z7052)
1 20MHz low profile crystal (X1)
1 high output sealed mini buzzer, PCB mounting (Altronics S6105)
1 2-pin header
1 20-pin header
1 20-way single row header socket (8mm high socket base)
1 micro U-style heatsink for TO-220 (19x19x9.5mm)

Semiconductors

1 PIC18F4550-I/P microcontroller (IC1) (available from www.futurlec.com)
1 LM2940CT-5 or LM2938ET-5.0 5.0V voltage regulator – TO-220 package (IC2)
1 LP2950CZ-3.0 voltage regulator TO-92 Package 3.3V (IC3)
1 BC338 transistor (Q1)
1 1N4148 diode (D1)
1 1N5819 Schottky diode (D2)

Capacitors

1 100µF 16V electrolytic (105°C rating)
1 10µF 16V tantalum
1 470nF MKT
2 220nF MKT
3 100nF monolithic
2 22pF ceramic

Resistors (0.25W 5%)

1 10Ω 2 3.3kΩ 1 6.8kΩ 1 8.2kΩ 1 10kΩ
1 22kΩ 3 47kΩ 3 82kΩ 1 100kΩ
1 10kΩ trimpot (vertical mount, front adjust)
1 LDR (light dependent resistor) 10kΩ to 1MΩ (Altronics Z1621) (optional – see text)

Parts List for the Sealed Case

1 UB3 box [Jaycar HB6013 (black) or HB6023 (grey)]
1 IP67 waterproof USB "type B" female chassis connector, (Altronics P9725)
1 USB sealing cap (Altronics P9840) [for when the USB connector is not in use]
1 IP67 6-pin locking chassis mount male connector (Altronics P9366)
1 IP67 6-pin locking female line connector (Altronics P9356)
3 SPST momentary pushbutton switches, black solder tail (Altronics S1084 or Jaycar SP-0700)
6 PC Pin Sockets (Jaycar HP1260)
1 3mm thick Perspex or acrylic sheet, 3mm – cut to size for UB3 box (Jaycar HM-9509)
4 12mm M3 tapped spacer**
4 10mm M3 untapped spacer**
4 20mm M3 screw**
6 6mm M3 screw**
1 10mm M3 screw**
9 M3 star washer**
4 M3 flat washer**
1 M3 nut**

** *preferably nylon or marine-grade stainless steel*

Microchip PICkit 3 during software development.

With the case design shown there is plenty of space between the main board and the LCD module so you can use an IC socket for IC1, which makes fault-finding and testing much easier.

When handling the microcontroller and LCD you should take the standard precautions against electrostatic discharge which could zap these devices. This means making sure that your work surface, your soldering iron and you, are all grounded.

The LCD is not installed yet but its connectors can be. It plugs into a 20-pin connector on the main board via a single row 20-pin header strip. Start by inserting the long pins of the 20-way pin header strip through the matching holes on the LCD from the bottom. The plastic spacer should be flush on the underside of the display's PCB and the shorter pins underneath.

Solder and trim the pins on the top of the board while ensuring that the spacer underneath remains flush with the board. Then remove the plastic spacer leaving just the pins. This is best done with a fine screwdriver – lever down one end of the spacer by a few millimetres, then the other end followed by the middle. After repeating this a few times the plastic spacer will slide off the pins.

The GPS module is supplied with a cable with identical connectors on each end. Cut off one of the connectors, bare the wires and solder to the pads marked CON5. The grey wire goes to pad 1 which is marked accordingly (the left hand pad when viewing the board with the silk screen printing the right way up).

The other wires should be soldered in the same sequence as they emerge from the connector.

Testing

As a final check, closely inspect the board with a high power magnifying glass. Carefully check every solder joint for blobs, shorts or poor joints. With all components in place (except the microcontroller, switches, GPS and LCD) you should make a quick test to ensure that the voltages are correct.

With 12V power applied you should be able to measure about 5.3V between pins 11 and 12 of the microcontroller socket. Between pins 2 and 5 of the GPS connector (CON5) you should be a ble to measure 3.3V. Both could vary by plus or minus 150mV.

Refer to Fig.3 for the measurement points. If you cannot measure the correct voltages you should check D1, D2, IC2, IC3 and the power connection.

You can now insert the pre-programmed PIC18F4550 into its socket (again, follow the component overlay on P84, as some PC boards show this upside down!), then plug the LCD and GPS into the PC board. When you apply 12V power the LCD should immediately show the firmware version followed by a message indicating that it is searching for satellites.

You may need to adjust the 10kΩ trimpot to get an image on the display and then continue adjusting it for a good contrast.

The device will start-up as a GPS Car Computer as that is the initial firmware loaded in the chip by the kit supplier. As explained in the next section, you then need to load the GPS Boat Computer firmware from your computer using the USB interface.

Loading the firmware

The firmware for the microcontroller is loaded in a two step process as illustrated in Fig 4.

First the full copy of the GPS Car Computer firmware version 1.1 needs to be programmed into a blank microcontroller using a PIC programmer. A copy of this firmware can be found on the SILICON CHIP website under Downloads for January 2010. You only need to do this once and from then on new firmware will always be loaded via the USB interface.

If you built your device from a kit of parts then the supplier should have already programmed the chip for you – so you can skip this and move onto the next step.

As Fig.4 shows this firmware contains a bootloader. This is a small portion of software, 2KB in size, which sits in the bottom of memory and watches to see if the SET button is held down while power is applied.

The best way to load this software is to disconnect the GPS Boat Computer from a power source (eg, unplug CON1), place a jumper on JP1, and connect the GPS Boat Computer to your computer (via a USB cable plugged into CON2) while holding down the SET button. Placing the jumper on JP1 means that the GPS Boat Computer will be powered from the USB interface.

When this condition is detected the bootloader will take control of the USB port and reconfigure it to pretend that

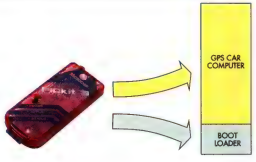

Fig.4a: a "factory fresh" or blank microcontroller must first be programmed using a PIC programmer such as the PICkit3. This will load two components, a bootloader, which is responsible for future program updates and the GPS Car Computer firmware. If your microcontroller came in a kit then the kit supplier should have already programmed the microcontroller and you can skip this step.

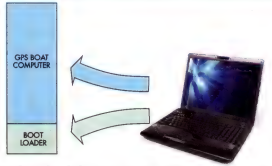

Fig.4b: to load the GPS Boat Computer firmware, you should hold down the SET button while applying power. The bootloader will take control and establish communications with your computer over the USB interface, allowing you to upload new firmware via USB – no programmer is required. Using this method you can also load other updates or revert to the GPS Car Computer firmware.

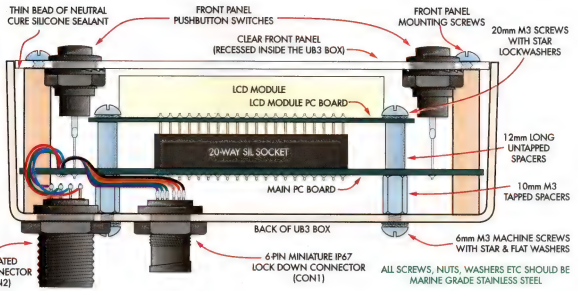

Fig.5: while the electronics is basically the same, there are some layout differences between this diagram and the GPS Car Computer from last January – mostly to do with ensuring moist air or even the occasional greenie doesn't play havoc with the works!

it is a Microchip PICDEM FS evaluation board. Your computer will recognise this new device and prompt you to load the appropriate device driver (included in the software package).

To upload the GPS Boat Computer firmware you need to run software that knows how to reprogram the PICDEM FS board (which is what the microcontroller is pretending to be). As shown in Fig.4 this software will overwrite the upper portion of the firmware while still leaving the bootloader (that is stored in lower memory) in control. When you subsequently remove and reapply the power (without holding down any buttons) the micro will run the firmware in the upper portion of memory and your gadget will have changed to a GPS Boat Computer.

While this process might sound complex reprogramming only takes 20 seconds and all the necessary software and instructions are included in the software package on the SILICON CHIP website. The software package also includes a USB-loadable version of the GPS Car Computer firmware so that you can go back to that if you need to. However, you should note that all settings will be lost if you do this.

Troubleshooting

With only a few active components in this project it should be easy to track down any faults. Firstly, check the two supply voltages as described earlier, as nothing much will happen if they are not correct.

Next, check the microcontroller. This is best done by carefully measuring the voltage between pin 4 and pin 12, which should be between 1.2V and 1.5V. This voltage is created by the internal voltage reference and implies that the firmware is running and that the microcontroller is OK. In the absence of this voltage, check pins 13 and 14 with a 'scope for a 20MHz sine wave, indicating that the main clock is present.

Next is the LCD. First check the voltage on pin 3 of the LCD (V_{CON}) – it should be under 0.5V. This voltage is controlled by the 10kΩ trimpot (contrast) and if not correctly adjusted the display will appear blank.

The microcontroller only sends data to the LCD and does not expect any response. So, even with the LCD removed or faulty, you should still see signals on the data lines to the LCD. If the LCD is blank or showing rubbish the only things that you can do is check that it is plugged in correctly (watch for bent pins!) and that there are no solder bridges on the connector.

With the microcontroller running and the LCD showing the startup message the only other fault would be with the GPS module. The microcontroller will display an error message if the module is not connected or running, so that type of fault should be obvious.

Don't worry if the GPS Boat Computer initially sits with the LCD showing a message saying "SEARCHING". The GPS module normally keeps track of the available satellites in its internal memory, which is kept alive by a super capacitor. If this capacitor has lost its charge, the module will have to reload the tracking information from a satellite - and this can take up to 15 minutes. This only happens once, subsequently the GPS will use its memory of the data and start up in 45 seconds or less.

If, after a long wait, the GPS module still cannot get a signal you should try moving the unit outside or near a window so that it can "see" the sky. While it is searching you can press the Set button to get the Signal Levels display – this will show you how many satellites can be seen and their signal levels.

It is possible for the GPS module or the microcontroller lock up or crash. If this happens you can press and hold the DOWN button while plugging the GPS Boat Computer into power. This will cause the microcontroller to reset

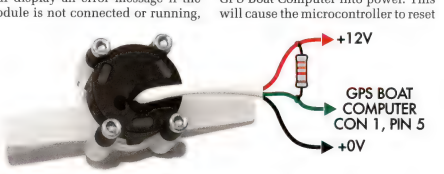

Fig.6: the connections we made to our flow sensor. The 3.3kΩ resistor is required to pull up the output voltage as the sensor used an open-collector output. Your sensor will probably be similar but check the documentation.

Resistor Colour Codes

No.	Value	4-Band Code (1%)	5-Band Code (1%)
1	100kΩ	brown black yellow brown	brown black black orange brown
3	82kΩ	grey red orange brown	grey red black red brown
3	47kΩ	yellow violet orange brown	yellow violet black red brown
1	22kΩ	red red orange brown	red red black red brown
1	10kΩ	brown black orange brown	brown black black red brown
1	8.2kΩ	grey red red brown	grey red black brown brown
1	6.8kΩ	blue grey red brown	blue grey black brown brown
2	3.3kΩ	orange orange red brown	orange orange black brown brown
1	10Ω	brown black black brown	brown black black gold brown

Capacitor Codes

Value	µF value	IEC Code	EIA Code
470nF	0.47uF	470n	474
220nF	0.22uF	220n	224
100nF	0.1uF	100n	104
22pF	–	22p	22

itself to the default settings and send a command to the GPS module also resetting it to its factory defaults.

Spray Proof Enclosure

The original GPS Car Computer was designed for use in a car and therefore no attempt was made to protect its internals from the elements. This is definitely not acceptable in a marine environment. We recommended a case that can be completely sealed so that the electronics are protected from corrosive salt air (it doesn't even have to be salt spray).

It's not so much that the case needs to be waterproof to stop water getting in – if that situation occurs you're in much more trouble than a GPS Boat Computer can assist with – but the moist air on a boat usually gets into everything and starts attacking any metal it can.

Nigel Hall, who suggested the GPS Boat Computer, also developed an alternative case and we describe it here. Nigel's design comprises a Jaycar UB3 "jiffy" box (130 x 67 x 43 mm) with a front panel fabricated from a sheet of clear Perspex or Acrylic.

The push buttons are mounted on the front panel while the USB connector (CON2) and the 6 pin connector (CON1) are panel mounting components and are attached to the rear panel. These connectors are IP67 rated (immersion up to 1m) and have a rubber sealing washer which is best installed on the inside of the box. While the front panel push buttons are not rated at such a high standard they should be adequate.

These switches and connectors replace the corresponding board mounted components used in the GPS Car Computer so they need to be wired to the solder pads for the original components. Fig.2 illustrates the wiring for the connectors (CON1 and CON2) and this should be implemented using lightweight hookup wire running from solder stakes on the PC board to the connectors.

The front panel buttons also connect to the PC board with lightweight hookup wire The best way to do this is use short wires and PC pin sockets (Jaycar HP1260) to plug the leads onto pins soldered onto the main board. This will allow you to easily remove the front panel for testing without having to use long and unsightly wires which could be seen through the clear front panel.

Assembly

As Fig.5 shows, the completed assembly of main PC board and the LCD module are separated by spacers and mount using more spacers onto the bottom of the box. When putting everything together it is best to first attach the LCD module to the main board using the 20mm machine screws which run through the 12mm untapped spacers and fasten onto the 10mm tapped spacers. This assembly can then be easily lowered into the box and secured by the 6mm screws through the bottom of the box.

To allow the GPS module to fit in its position you will need to trim some of the plastic ribs. You'll also need to drill a hole in the rear so that the external antenna connector can poke though. This also helps to hold the module in position. Normally you will not need access to this connector so you can cover the hole with a square of adhesive tape to keep the elements out. Even better for waterproofing is a dob of neutral-cure silicone sealant – but you must be sure you're never going to connect an external antenna!

In the Jaycar UB3 box the top of the mounting pillars (which secure the front panel) sit about 3mm below the top edge of the box. This allows you to sit the front panel inside the edges of the box and, using some marine-grade stainless steel screws (not the ones supplied with the box!), securely fasten the front panel to the mounting pillars.

This cannot be easily achieved with the Altronics version of the UB3 box, as their mounting pillars extend to the top of the box, preventing you from

The rear of the prototype spray-proof case showing the mounting screws, weather-proof connectors and the hole drilled for the GPS module's external antenna connector. This hole should be sealed when not in use. (courtesy Nigel Hall).

easily recessing the front panel. You could grind down these pillars to allow for recessing but achieving the same level on each pillar migh be difficult.

For protection, immediately before screwing the front panel in place (and only after all testing and troubleshooting) a thin bead of silicone sealant can be run around the edge of the Perspex or Acrylic lid to properly seal it. As a final touch you could, if you wished to hide the electronics, attach a label (with a cutout for the LCD) on the inside surface of the clear front panel.

Wherever possible, the screws, nuts, washers and spacers used should be marine-grade stainless steel (which you may have to source from a ships' chandlery). Even with a sealed case standard hardware will corrode on a boat, often quite quickly.

One unfortunate outcome of a sealed case is that it could get quite hot inside due to the heat generated by the LM2940 regulator (IC2). To reduce this, you could place an external 12Ω 5W resistor in series with the 12V supply (on pin 4 of CON1). This will reduce the supply voltage to the GPS Boat Computer by 3 volts and correspondingly reduce the heat generated by the regulator by up to 40%.

Installation

There are five connections that you need to make from the mini-DIN power and input connector (CON1) to your boat's electrical system. These are illustrated in Fig.2 and consist of:

- Pin 4, which is the main power (+12V) input to the GPS Boat Computer and should be connected to a power source that is powered on whenever you would want to use the GPS Boat Computer. This is not usually the engine ignition switch, as there are times when you want to know your position without the engine running (eg, drifting over a fishing ground).

  As explained in the previous section, if you are using the sealed case design you should also install an external 15Ω 5W resistor in series with the +12V supply to reduce the heat generated inside the case. The supply must also be protected with a 500mA fuse either inline or via a fuse block.
- Pin 3 is the ground (negative).
- Pin 2 should connect to the engine ignition circuit and is used to determine the engine's running time. This input should be at +12V when the engine is running and zero volts when not.
- Pin 1 is used to control the brightness of the display when an LDR is not used. It should be wired to the circuit for the boat's navigation lights so that +12V is present on the line when the navigation lights are illuminated (ie, after sunset).
- Pin 5 is the input for the fuel consumption measurement and should be connected to either the fuel injector solenoid or fuel flow sensor depending on the version of the firmware loaded.
- Pin 6 is not connected. It is available for future development.

If you are using the fuel injector sense method you will have to connect pin 5 on CON1 to the negative lead of one of the fuel injector solenoids, preferably near the engine management unit as that position should be more protected from salt spray and other environmental hazards.

If you are using a paddle-wheel sensor you will probably need to connect it to the same source of power used by the GPS Boat Computer and install a pull-up resistor on the output line which connects to the GPS Boat Computer. Fig.6 shows the connections that we made to our sensor – yours will probably be similar.

The reason for the resistor is that most paddle-wheel sensors have an open collector output where a transistor in the sensor will pull the output low and the resistor is needed to pull it high again when the transistor is turned off. Typically a 3.3kΩ resistor wired to the 12V supply will be sufficient but your sensor might already have the resistor built in, so check the documentation.

You should also refer to the documentation for your device when determining how and where it should be mounted.

Generally the manufacturer will recommend that it be mounted vertically between the fuel pump and the carburettor but before any pressure regulator. This is to minimise the formation of vapour pockets.

So, that is the GPS Boat Computer. All that is left is to wish you "happy navigating" (and perhaps "great fishing!").

For up to date errata, notes and new firmware go to http://geoffg.net/boatcomputer.html. SC

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By RODNEY CHAMPNESS, VK3UG

The Astor DL 4-valve mantel receiver

An austerity model for the post-war era

The Astor DL is a little broadcast-band 4-valve mantel receiver that's housed in a bakelite case. The circuit is quite simple but it still had quite a few challenges in store for me.

A FELLOW CLUB member recently decided to tackle the restoration of an old Astor DL 4-valve receiver for a friend of his. He began by cleaning the set and then replacing any parts that, based on experience, were likely to be faulty or which might give trouble later on. The replacement parts were fitted in exactly the same places as the originals, to conform to the original layout. This is always a good idea unless you are very experienced. Deviating from the original layout can lead to instability and other problems.

However, despite his careful work, my friend ran into all sorts of problems with this set, particularly with microphonics and instability. We'll take a closer look at the work he did and the steps we took to overcome the problems later on. First though, let's take a look at the circuit.

Circuit details

The Astor DL is one of the few sets not featured in the Australian Official Radio Service Manuals (AORSM) and so few restorers have any information on this set. However, I was fortunate enough to have a copy of "Those 'Missing' Radio Services Manuals", 1939-1942, which was compiled by the late Ray Kelly. It also has some service data on a few 1947 receivers that were missed in the AORSMs and the Astor DL is included. Without the circuit, I could have been chasing my tail sorting out the problems in this set for quite some time.

Fig.1 shows the circuit details. As can be seen, the antenna circuit uses both capacitive top-coupling and inductive coupling to the tuned secondary winding. The tuned signal is applied to the signal grid of a 6A8G valve which functions as the converter (ie, mixer and local oscillator). The oscillator tuned circuit (bottom left of Fig.1) operates 455kHz higher than the tuned signal and mixing these signals produces the 455kHz IF (intermediate frequency) signal (along with others).

This 455kHz IF signal is applied to the first IF transformer (37) which is tuned to 455kHz. It is then applied to a 6B8G IF amplifier stage after which it is fed to the detector and AGC diodes in the 6B8G envelope. The detected (or demodulated) audio signal appears across the associated 0.5MΩ resistor (23).

From there, the audio signal is fed via a 0.05μF (50nF) capacitor (6) to a 6V6G audio output valve, then to the speaker transformer and finally to the loudspeaker. Astor were renowned for their complex and quite effective tone-cum-negative feedback circuits but in this receiver, this circuitry is missing and has been replaced with a very simple negative feedback system.

This consists of taking the cathode

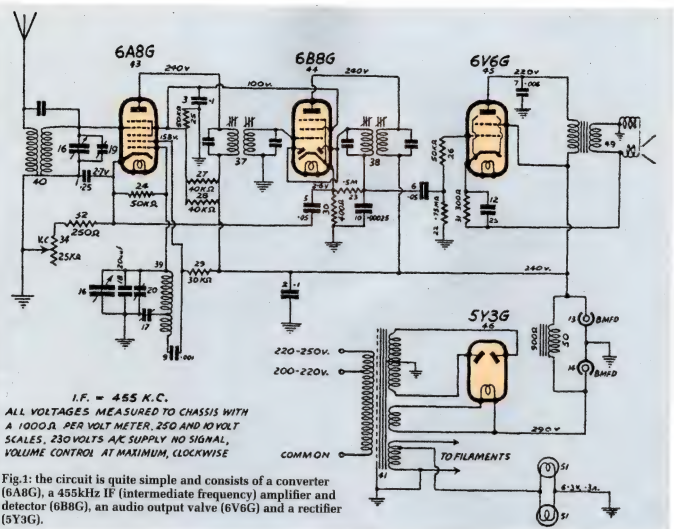

Fig.1: the circuit is quite simple and consists of a converter (6A8G), a 455kHz IF (intermediate frequency) amplifier and detector (6B8G), an audio output valve (6V6G) and a rectifier (5Y3G).

return of the 6V6G to earth via the voice coil of the speaker. It gives around 3dB of negative feedback which is probably all that could be tolerated in a set with only one audio stage. Any more and the volume would have been unacceptably low on weaker stations.

It's puzzling as to why Astor didn't take the 300Ω cathode resistor (31) straight to the chassis and simply connect the 25μF electrolytic capacitor (12) to the voice coil. The feedback would have been almost the same but with no DC current through the voice coil. This would mean that the cone would rest in its natural position instead of being biased away from this neutral point.

In theory, the DC offset in the Astor DL will restrict the volume that can be reached without undue distortion. However, since there's only one audio stage and the volume is limited anyway, it really did not matter in this receiver.

The volume is controlled by using a 25kΩ potentiometer (34) to vary the cathode resistance on the 6A8G converter valve. This effectively varies the bias to the signal grid of the valve. The oscillator section is not affected, as its bias is developed across an oscillator grid resistor (24) of 50kΩ and is not reliant on the cathode-to-earth voltage.

When the receiver is operating at full volume, the wiper of the 25kΩ pot will be at the end attached to the 250Ω fixed cathode resistor. Conversely, winding the pot the other way (ie, to minimum volume) gives the maximum series resistance and the signal grid section of the valve will be biased off. As a result, there is little or no audio output from the receiver (this will depend on the individual characteristics of the particular valve in use).

As mentioned in the recent articles on automatic gain control (AGC), it really is difficult to understand why AGC was omitted from so many designs. More up-market receivers from the same manufacturers and of the same vintage had AGC as a matter of course and in this receiver it would have been easy and cheap to include it.

Of course, it's possible that some manufacturers deliberately omitted AGC from their cheaper receivers in order to make it a selling point in their more expensive sets!

Power supply circuitry

Power is supplied to the receiver via a mains transformer, while a 5Y3G rectifies the output from the centre-tapped HT winding. Note that the primary is tapped so that the receiver can be used with any 50Hz AC supply from 200-250VAC.

The two plates of the 5Y3G are connected to either end of the HT secondary winding, while the centre-tap goes to chassis. The HT output is then taken from the heater and applied to a filter network consisting of a choke (or inductor) and two 8μF electrolytic capacitors (one on either side). These

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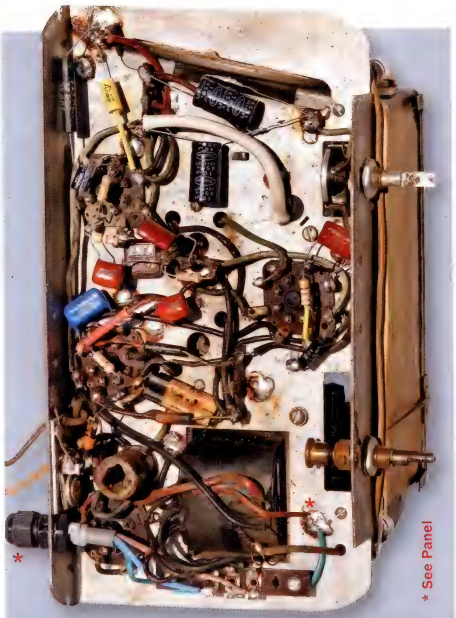


This view shows the underside of the chassis minus the metal shield for the 6B8G IF stage. Note the proximity of the mains connections to the edge of the chassis. By the way, we don't recommend using a cable gland to secure the mains lead, nor do we recommend soldering the mains Earth lead directly to the chassis (see panel for more details).

provide the necessary ripple filtering on the HT line.

The transformer also has two filament windings – a 5V winding for the 5Y3G rectifier and a 6.3V winding for the remaining valve heaters. The dial lamps are fed from a tap on the 6.3V winding. As a result, around 5V is applied to the lamps which means that they will last longer than if the full 6.3V was applied.

Note that the three valves in the signal chain (6A8G, 6B8G & 7V6G) all use cathode bias. This circuit technique was common from the 1930s-50s but was generally superseded by back bias in the 1960s, as this was both simpler and cheaper. Back bias did have one disadvantage though – checking the current through each individual valve by measuring the voltage drop across the cathode resistor was no longer possible.

Physical details

As can be seen from the photos, a small brown bakelite cabinet was used to house the Astor DL chassis. Indeed, this same cabinet style was used for many 4-valve Astor sets.

In terms of appearance, it is quite an appealing little receiver with a large dial scale. This dial scale has no slots in it, unlike many other dial scales. As a result, the speaker is mounted at the lefthand end of the chassis and faces out to one side.

The dial scale uses a normal "slide type" pointer system and works well. The drive mechanism uses a drive shaft with two or three turns of dial cord wound around it and then connected to the pointer and a dial drum.

The chassis is easily removed from the cabinet. First, the four screws holding the Masonite back on the set are removed, then the two control knobs and finally the two retaining screws that attach the back edge of the chassis to the cabinet. The set can then be slid out of the cabinet.

That done, the first thing to note is that the power supply and the converter stage of the receiver are intermingled. As a result, it is necessary to be sure which part of the circuit is being worked on. A problem that was experienced later on made us wonder if some unwanted interaction was taking place between these two sections but more of that later.

The loudspeaker and its transformer are mounted at the other end of the chassis to the power supply. This is good practice as it minimises any hum induction into the speaker transformer from the power transformer. The IF valve is near the front of the chassis, making it difficult to access when the chassis is in the cabinet. In addition, the "up-in-the-air" mounting arrangement for the antenna coil makes it vulnerable to damage when the set is being serviced or restored.

The under-chassis parts are all easily accessed, although the 6B8G has a shield over the socket to minimise any IF feedback that could lead to instability. **One thing you do have to be mindful of when tipping the chassis over for service is that the mains terminations are easily touched, since they are quite close to the edge of the chassis.** If the set is connected to power, then it's all too easy to receive a potentially fatal electric shock.

My advice is to always disconnect such sets from the wall socket when turning them over to avoid such risk. In addition, you should always use a residual current device (RCD) protected power socket when servicing old radio sets. That way, if you do make accidental contact with the mains, there is less chance of electrocution.

In my opinion, Astor should have covered the transformer mains wir-

ing terminals for safety reasons. They should also have positioned the antenna coil better so it could not be so easily damaged during service.

Cleaning the cabinet

The cabinet and the knobs were in quite good condition and only required cleaning. First, the cabinet was washed with soapy water, taking care not to get the dial scale wet. The knobs were then cleaned in the same way, with a nailbrush used to clean the grime from between the flutes.

Finally, the cabinet was rubbed over using automotive cut and polish compound and this brought out its original lustre. It now looks almost as good as new.

Chassis restoration

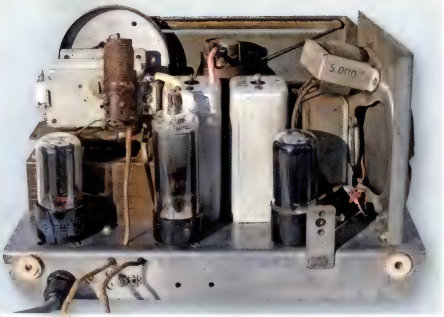
My friend had done a considerable amount of work on the old Astor before seeking my help with some stubborn technical problems. First, all accessible areas of the chassis had been carefully cleaned with a small wire brush and it now looks quite shiny in those places.

Unfortunately though, someone before him had tried cleaning the back of the dial scale with the result that some of the markings had been removed. This is a job that must always be approached with caution. Some station and frequency identifications on dial scales are firmly attached but many are now only just sitting there, waiting to fall off if they are touched.

Since first making that same mistake many years ago, I now always test-clean an inconspicuous area to see how well the markings are attached to the glass or plastic. If it is about to fall off, I leave it well alone. One possibility is to spray the markings with a clear lacquer to keep them in place but that will very much depend on the individual set. If there is dust on the dial scale, this may not work too well.

Both the 5Y3G and 6B8G valves had been replaced, as the originals tested faulty in my friend's valve tester. The other two valves tested OK and were cleaned with soapy water before being reinstalled in their sockets.

Be careful when cleaning valves though, as some type numbers will easily come off the valve envelope. I always tip the octal valves upside down and only rub soapy water on the glass envelopes, making sure that no water gets into the base as this may ruin the valve due to electrical leakage after it dries. I then leave the valve to dry before placing it back into the receiver.



The parts on the top of the chassis are readily accessible but mounting the aerial coil so high up leaves it prone to damage during servicing.

The paper and electrolytic capacitors had all been replaced, while several out-of-tolerance resistors had also been changed. In addition, any leads with cracked insulation had been sleeved to prevent short circuits.

Once this work had been done, my friend checked for shorts between the HT line and chassis. Checks were also carried out on the power transformer to ensure it wasn't breaking down between the various windings and the frame. These transformer checks were carried out using a high-voltage insulation tester, as described some years ago in SILICON CHIP.

Finally, a new 3-core power lead was fitted to the set, along with an antenna and earth. It was time for the smoke test.

Well, it was all something of an anti-climax because no radio stations could be heard, even when the volume control was at maximum. What my friend did find though was that the set was very microphonic, particularly if any of the RF valves were flicked with a finger to give them a very mild physical shock.

Microphonics

For those who haven't experienced this effect, many valves in a receiver, if lightly tapped, will generate a "ringing" noise in the loudspeaker. This is often due to broken welds in the valve grid structures vibrating after being mechanically jolted. However, it can also occur in valves with no weld breaks if there is high enough gain in the amplifier train. That is why some valves in high-gain audio amplifier stages are mounted on resilient mounts.

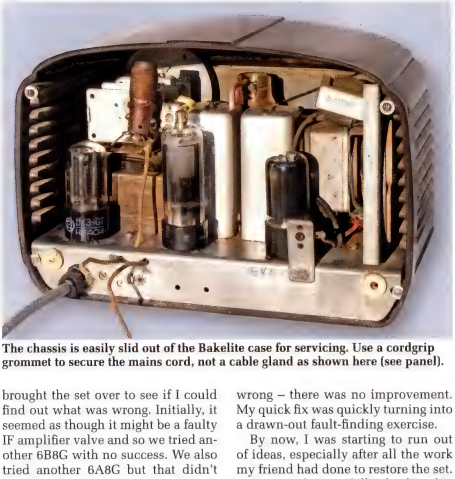
Unfortunately, this ringing sound was all that my friend was getting out of the receiver, with no sign of any stations. As a result, he eventually

Securely Anchoring The Mains Cord

As shown in the photos, the mains cord has been secured to the Astor DL's chassis using a cable gland. However, we don't recommend this method as it's too easy to undo the nut securing the gland from outside the case.

Instead, we recommend that an approved cordgrip grommet be used to secure the mains cable to the chassis. This must be fitted to a correctly profiled hole to ensure it securely locks the mains cord into place.

We also note that the mains Earth lead has been soldered to the chassis and again we don't consider this as being safe and secure (the solder could easily separate from the chassis). Instead, we recommend that restorers purchase a mains lead with an eyelet lug pre-crimped to the Earth lead which can then be bolted to the chassis and secured using a star washer and two lock nuts.



The chassis is easily slid out of the Bakelite case for servicing. Use a cordgrip grommet to secure the mains cord, not a cable gland as shown here (see panel).

brought the set over to see if I could find out what was wrong. Initially, it seemed as though it might be a faulty IF amplifier valve and so we tried another 6B8G with no success. We also tried another 6A8G but that didn't help either.

The audio amplifier stage was working well though and gave a healthy blurt whenever the grid of the 6V6G was touched. So the problem was somewhere in the RF or IF stages.

IF instability

A quick check showed that the voltages around these stage all seemed to be reasonably normal, so it was time to bring out the big guns. I have a tuned signal tracer and placing its RF probe close to the IF amplifier (6B8G) showed that it was oscillating vigorously. So what could be wrong around the IF amplifier?

The first item to be checked was the screen bypass on the 6B8G. It tested correctly and the only thing I did was to shorten its leads and reposition the chassis earth. This gave no improvement so we turned our attention to the valve shields. These had become corroded over the years, so the 6B8G was removed and the surfaces of the shield, the circlip and the earthing spigot on the valve were all cleaned using a kitchen scouring pad.

I expected that this would fix the problem but was quickly proved wrong – there was no improvement. My quick fix was quickly turning into a drawn-out fault-finding exercise.

By now, I was starting to run out of ideas, especially after all the work my friend had done to restore the set. However, after carefully checking his work, we eventually spotted a wiring mistake in the set although it's not certain when this occurred. The 0.05µF (50nF) capacitor between the cathode of the 6A8G went to pin 5 of the 6B8G instead of to pin 8. Since pin 5 is one of the detector diodes in the 6B8G, this wiring error very effectively stopped the stage from detecting signals.

My friend was sure that he hadn't touched this section and it certainly looked as though the soldered joints there hadn't been disturbed for many years. So just how the set got to be that way is something of a mystery.

We corrected the wiring error and this time when we applied power, the set was working. However, something was still not right. While it was pulling in stations OK, the IF stage was still oscillating wildly, with the result that tunable whistles were appearing across the band.

Well we'd cured one problem only to uncover another. So why was the IF stage still oscillating when everything looked OK? There just had to be another wiring error somewhere.

At this stage, I decided that the best approach was to carefully check all the wiring around the front-end and IF amplifier stages. This paid dividends as I eventually discovered that I couldn't find the cathode bypass capacitor on the frequency converter (6A8G). It wasn't hidden from view either – it just wasn't there.

In fact, going on the solder joints, it had never been in the circuit.

My initial reaction was that this would simply drop the gain of the converter but that it wasn't the cause of the instability problem. However, the converter would work better if the missing capacitor was in place and so this was duly fitted.

When the set was subsequently turned on, we were surprised to find that it was no longer oscillating and that its performance was actually quite good. So why had the IF stage oscillated when the bypass capacitor in another stage was missing?

Positive feedback

The answer is that the 0.05µF bypass capacitor wired between the cathodes of both RF valves forms a positive feedback path. This had the potential for the set to oscillate on 455kHz and oscillate it certainly did. By fitting the missing bypass from the 6A8G cathode to earth, this controlled the amount of feedback on 455kHz so that the IF stage was only slightly regenerative.

In fact, when I looked at all the general information on the receiver, I found that this technique was deliberate. Basically, the service bulletin states that the receiver has some positive feedback to give a small increase in performance. What really puzzles me is that the 6A8G cathode bypass had obviously never been fitted, so it must have been a dog of a set from new.

Alignment

Having solved the instability problem, it was now time to check the alignment. The IF stage alignment was pretty much spot on but the front-end did require some adjustment. The receiver would only tune to around 1500kHz at the top end of the dial and this needed to be extended to cover the entire broadcast band.

Unfortunately, the wire-type trimmer (20) in the oscillator section couldn't be adjusted, so I removed it. Without this trimmer, the set would tune up to 2000kHz. I then fitted an adjustable trimmer and was able to

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ASK SILICON CHIP

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Button cells and LEDs

I've got a "Light Sabre" key-ring that you can see here: **http://www.zazz.com.au/pastproducts.php?past=1466**

It is very simple – press the button and it lights up. Unfortunately, the four LR41 batteries which came with the key-ring are running out (and really didn't last that long either to be honest). I've been looking around and a local electronics ship has the battery for sale in single units for $4.

Given that I need four batteries, I was hoping to find a cheaper equivalent, especially since the lifespan is monthly! A hearing-aid shop has a pack of six for about $6 which is more reasonable but they are PR41.

From the Wikipedia page **http://en.wikipedia.org/wiki/List_of_battery_sizes** you can see that LR41 is around 25-32/38-45mAh whilst the PR41 is 160mAh. Can I safely substitute the PR41 for the LR41? (B. G., via email).

● All button cells have a pretty short life when they are used to drive LEDs – as yours is. In practice, you can substitute any button cell of the same voltage, provided it will physically fit. A 160mAh cell will last about four times longer than a 38mAh cell so it would be a better choice. Jaycar also have an equivalent at $2 each and if you do a Google search for LR41 you will find plenty of suppliers who can do 10-packs for $1/cell or less. They might not last quite as long but they are much cheaper. Or just go to your local $2 shop and you should be able to pick up a similar deal.

Mind you, if you buy the original product, it will probably be about the same cost as replacing the batteries!

Speed controller for a bowling machine

I purchased two 12VDC 10A Speed Controller kits (SILICON CHIP, June 1997) for a cricket bowling machine I am designing. The controllers work very well, save for one small problem that I have and am not sure if is correct or not.

When pot VR1 is slowly rotated to increase motor speed, it gets to roughly half-way and maximum voltage is achieved (ie, maximum motor speed) and stays at maximum output voltage for the other half of the pot travel.

I have double and triple-checked that all components are fitted correctly and not sure why I have this problem. I would love to have the use of the whole pot as it would give greater controllability of my motors.

Can you tell me if this is the way these controllers are supposed to work or possible solutions? (P. M., via email).

● The potentiometer range can be improved by placing a resistor in series with the potentiometer at the terminal that connects to the 5V reference at pin 14 of IC1. A 4.7kΩ resistor should be suitable.

Added capacitor may give weaker spark

Is it possible on your Ignition Coil Driver kit (SILICON CHIP, March 2007) to add a capacitor in parallel to the four zener diodes which go from the output of Q1 back to earth, without damaging Q1? This would be a standard ignition capacitor normally paralleled across the points in a points-fired system. I'm not sure of the value but I think it would be somewhere in the 20-40 mF range.

I am fitting the kit to a 1970 twin cylinder 4-stroke motorcycle with a twin outlet coil, ie, it fires both cylinders off the same coil simultaneously. The reason for using the kit is to replace

Battery Capacity Meter In A 4WD

I run a 100Ah auxiliary battery in my 4WD. To do this I have a second alternator to charge it, a solar panel and an automatic battery charger (which is connected whenever the vehicle is parked). A portable generator is used when there is not enough sun.

Having purchased your Battery Capacity Meter, how should I connect these? I presume the solar panel and alternator go through the shunt while the automatic charger goes direct to battery. Am I right?

Secondly, on the Capacity Meter there is a provision for a 14-pin socket. Is this for an external display? I wish to put one on the dash or in a more convenient position than under the bonnet.

Will two displays run OK? And perhaps I could add a second keypad or would I need to use optocouplers? (E. L., via email).

● We made provision for two different LCD modules in this project. The 14-pin connector is for the Jaycar LCD module, while the other is for the Altronics LCD module. You cannot easily connect two LCD displays but if you wish to have the display mounted somewhere else you could run ribbon cable to the PC board.

The way to connect your equipment is as follows: connect them as you would normally, with the chargers connected to the battery and the load connected to the battery. Then disconnect the battery positive terminal and connect it instead to the left terminal of the shunt (looking at the meter in the normal orientation) and connect the chargers to the other shunt terminal, as shown on page 23 of the June 2009 issue.

You could connect the automatic battery charger directly to the battery or via the shunt. If it is connected directly to the battery it means that you won't be able to measure its charging current.

Fridge Fan Timer To Save Power

I have a small fridge just for bar use and it has a fan for the condenser and a fan for the evaporator. The condenser fan starts and stops with the compressor but the evaporator fan runs all the time.

I have changed the wiring to stop the evaporator fan with the compressor to save some power as the fan does not need to be run all the time. The fridge is only opened rarely so doesn't lose much cold through door opening.

What I want is to have the fan run for about 10 minutes after the compressor stops, to maximise the coolness of the evaporator. The Fan Timer kit (SILICON CHIP, October 2005) would be perfect for my fridge except I need to switch the Neutral wire rather than the Active one. Is there a way that the circuit can be modified and used for my application? (P. B., via email).

● The fan timer is not easily modified to switch the Neutral instead of the Active. However, it should be possible to rewire the evaporative fan wiring so that it requires a switched Active to power it.

Note that the fan timer should be permanently powered with its switch input connected to the compressor via a 1N4007 diode (anode to switch side, cathode to the 2.2kΩ resistor). The diode will prevent the compressor pulling the switch input signal at pin 6 of IC1 below its common ground that floats 5V below Active.

It is assumed the compressor is switched on via an Active power connection rather than a switched Neutral.

The project is not available as a kit. The PC board and programmed PIC are available from **www.rcsradio.com.au** or **sales@rcsradio.com.au** The PC board and programmed PIC numbers are 10110051 for the PC board and 1011005A for the programmed PIC.

Other parts are available from Jaycar or Altronics.

points which are no longer available. I have at present fitted a CDI system which fires a short hot spark, which does not seem to suit this motor's combustion characteristics.

My intention is to use my existing magnetic pick-up which would suit the kit, however I would like to fit the capacitor mentioned to form an oscillating circuit as with the points system. This should give me a longer duration spark. It will also allow me to use the original higher impedance coil. If this is possible, the spark characteristics should be reasonably similar to the original.

If you think this is not likely to work, then your suggestions would be appreciated. (R. B., via email).

● You can add a capacitor across the coil driver transistor if you want to. We are not sure if you mean millifarads or microfarads when you say the capacitor would be "somewhere in the 20-40 mF range". However, these values seem too large – the points capacitor is usually about 0.22 microfarads (0.22μF) or in today's terminology, 220 nanofarads (220nF).

In practice though, we doubt whether connecting the capacitor will have the right effect. In a points system, the capacitor is absolutely essential, partly to stop serious arcing across the points contacts and also to deliver a strong spark; with an open-circuit capacitor, the spark will be very weak.

However, in a transistor-switched system, the transistor controls the risetime of the voltage developed across the coil primary winding and this develops a very strong spark. Adding the capacitor will slow down the switching characteristic and may result in a weaker spark. By all means try it, but the result may be inconclusive at best.

Traction monitor for gas turbine racer

I am building a Gas Turbine Streamliner to race at Lake Gairdner in South Australia with a Rolls Royce Nimbus engine from a Westland Wasp helicopter. Most crashes on the salt lake are caused by one thing – the back loses traction, front swaps to back and things get untidy such as here with a RX7 at Bonneville: **http://www.youtube.com/watch?v=CNYIjG3se3I**

The problem is that as in a lot of motor racing Traction "Control" is specifically banned but Traction "Monitoring" is not. An ABS type frequency can be picked up from the front and rear wheels and fed to your Universal Frequency Switch project (SILICON CHIP, June 2007) but I would need it to compare front-to-back signals and get a line of LEDs to indicate 5% difference (spin), 10% difference etc up to say 50%, so the brakes can be hit or back off or whatever is needed.

Can you let me know if this is possible or if you have anything that will do this? (I. W., Kalamunda, WA).

● Have a look at the Speed Match article from the November 2009 issue. This would show the difference between wheel speeds on a meter. A centre reading on the meter would indicate no speed difference and a left or right indication from centre shows one wheel or the other is faster.

If you want a LED readout have a look at the Voltage Monitor from the May 2006 issue.

Beam-Break Trigger too sensitive

I bought the Beam-Break Trigger kit (SILICON CHIP, June 2009) from Altronics, as an add on to the Photoflash trigger kit (February 2009). I'm very pleased with the way it went together. I'm a photographer and teacher, not an electronics enthusiast, but I was able to follow the instructions easily.

My problem is that the sensor seems too sensitive. It is suggested to use a 30 x 12mm tube to form a hood for the sensor. That doesn't seem to be enough. In fact, I can't seem to find anything that will shield what appears to be ambient light setting off the trigger. In other words, the trigger is always on, unless I block the opening to the hole completely. And even the heat from my finger will set it off!

I have to block the hole with something like a steel ruler for the green LED to go out. My question is, have I done something wrong or is there a way to control the sensitivity or set it to zero at ambient levels? (M. B., via email).

● It sounds as if you may not have fitted an IR filter in front of the IR sensor in the receiver unit. You do need such a filter to avoid the "always on" problem you describe – as the filter reduces the level of non-IR light reaching the sensor. If there was no piece of filter material in the kit, we suggest that

you try using a small square (about 16 x 16mm) of "red" filter material, as these are usually transparent to IR wavelengths.

It may also be worthwhile to paint the inside of the input shielding tube matt black, to reduce its ability to reflect non-IR wavelengths.

Two PVRs cause contention

Just wondering if my question may be of interest to other readers of the magazine. I have just bought myself another SD Humax Smart PVR, having been extremely impressed with the first one I bought when they were originally sold in Australia. My problem now is that both PVRs respond to the remote, unless I either physically switch one unit off, as all my attempts to cover up the IR receiver on the units has failed.

The manual off and on is OK unless I forget that one unit is recording at the same time I want to watch or schedule a recording on the second unit. Is there any simple way, not being remotely versed in electronics or soldering, that I (or someone else who has the appropriate skills) could change the IR frequency on one PVR and its remote control. (M. H., via email).

● Unfortunately, you cannot change the codes that each PVR accepts and it is difficult to envisage a simple solution, apart from your own, ie, switching one unit off. However, you could try matching vertical and horizontal polarising filters over the IR sensors and remote IR LEDs of the PVRs.

DAC doesn't sound better

I recently completed the short-form kit of the Digital-to-Analog Converter project (SILICON CHIP, September, October & November 2009). I enjoyed building it and mounted it in the 1RU case as per the article. It worked straight away and locks on to a signal, etc.

My problem is that I cannot tell the difference in quality (which sounds OK in either case) between music fed directly to the amplifier or with the DAC in the signal path. I played both classical and rock CDs (a couple were marked HD).

I am using an LG DVD player DV490H (which has optical and coaxial outputs) hooked up to a Yamaha AV amplifier HTR-5560 (75W/channel, .06% THD). My left and right speakers are B&W 685s.

Using either the DVD optical or coax outputs directly to the amplifier or via the DAC seems to make no difference in sound quality. I realise this is not the highest quality set-up but I expected a noticeable difference in an A/B comparison. (T. L., via email).

● There are three reasons why you may not notice any improvement when adding the DAC to your sound system.

The first is that your LG DVD player may already have excellent audio quality. Our experience is that DVD players usually do not have excellent audio quality but that is not universal.

The second is that you may not find the difference obvious. How obvious the difference is depends on what kind of music you are playing and how well recorded/mastered the CDs are. With some CDs the improvement can be a lot more obvious than with others. It may also be hard to tell the difference without a direct A/B comparison, depending upon how critical a listener you are.

The third reason is the most likely and that is that your amplifier and/or speakers are introducing enough distortion to mask any improvements

Notes & Errata

Milliohm Meter Adaptor for DMMs, February 2010: the output reference pin of IC3 (pin 5) should not be connected to the Set Zero trimpot VR5 but should be connected to PC board ground instead. This will allow VR5 to set the output zero correctly.

To make this change, the copper track currently connecting to pin 5 of IC3 should be cut and the pin connected to pin 4 of the same IC via a short length of hookup wire. To give VR5 a greater adjustment range in order to cope with a "worst case" situation, the resistor in parallel with VR5 can be changed from 100Ω to 390Ω.

Hearing Loop Receiver (September 2010): there are some discrepancies between the circuit and the PC board.

On the overlay (Fig.2) op amp IC1 is incorrectly shown as an LM358 instead of TL072, as on the circuit. Also, the 10µF capacitor to the left of D2 on the Fig.2 overlay should be reversed in polarity.

On the circuit, the anode of diode D2 on the circuit diagram should connect to the anode of ZD1 rather than the 27kΩ resistor. Also on the circuit, the wiper of VR1 should connect to the 1kΩ resistor end rather than the 10µF capacitor.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine.

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Pure Class-B Amplifier Designs In ETI Magazine

I just built the Series 3000 (ETI 476) compact stereo amplifier from the November 1980 issue of ETI magazine. I'm having a bit of an issue with distortion at low volume levels in the left channel. When I increase the volume pot the distortion reduces considerably but not completely.

Could it be an earthing problem? I followed the wiring diagram to the letter in the article and checked and re-checked everything. Also after about five minutes of loud listening with the volume pot about half way the heatsink gets too hot to touch. Could it be related or is it another problem? Do you know if there were any errata or modifications to this project? (M. O., via email).

● This amplifier is a very bad design. You are hearing crossover distortion. In fact, we are surprised that you are only conscious of bad distortion in one channel. In reality, both channels will have bad crossover distortion at low power levels – it is unavoidable since the output transistors are biased off. There is no quiescent current and no way to adjust it.

Amazingly enough, the ETI circuit description recognises this as it says, on page 28 of the November 1980 issue: "The output stage devices – a TIP31C and complementary TIP32C – operate in pure class-B, the effects of crossover distortion being reduced by the feedback arrangements". Well, that's a lot of rot. In some ways, negative feedback can make crossover distortion worse!

The only way to mitigate this problem is to provide a way to set a small quiescent current in the output transistors. To do this, connect a 200Ω trimpot in series with the diode string D1, D2 and D3 and adjust it, with no signal applied and no load connected, for a voltage of 150mV DC across the output resistors R30 or R31.

This will result in a quiescent current of about 30mA through the output transistors. However, this will make the amplifier run even hotter.

Other similar class-B designs of the period were the ETI 452 Guitar Practice Amplifier and the ETI 453 General Purpose Module which preceded your amplifier. ETI stated at the time that "There's no need to re-invent the wheel!" Sadly, that particular wheel should never have been invented.

Also in 1980, in the February issue, ETI published their ETI 466 300W Brute Amplifier. This was a "proper" class AB design with quiescent current adjustment via a transistor Vbe multiplier. But it too was a dodgy design, with very poor PC board layout, even by the standards of the day. And it had load-line (SOAR) protection which was very bad in terms of distortion when driving real loudspeakers as opposed to resistive loads.

They say that "comparisons are odious" but we made similar disparaging remarks about the ETI 480 when we presented the SC480 (SILICON CHIP, January & February 2003). If readers want to build an amplifier module, steer well away from the old ETI designs and pick one from SILICON CHIP instead.

made earlier in the signal chain. Let's say your DVD player has 0.02% THD at 1kHz, which is not particularly good, and the new DAC has 0.002% THD at 1kHz. This seems like a big improvement (a factor of 10) but compared to your amplifier which is rated at 0.06%, both figures are lower.

In other words, most of the distortion in your system actually comes from the amplifier and loudspeakers.

Nicholas Vinen, the designer of the DAC project, actually has a home-theatre amplifier like you, a Harmon Kardon AVR7000 which was quite expensive when originally purchased but for listening to stereo music it is definitely not as good as a dedicated hifi stereo amplifier like the SILICON CHIP Ultra-LD amplifier. The difference is clearly audible in a direct comparison with the same speakers, CD player, etc – just by swapping over the amplifiers. THD of the Ultra-LD is around 0.002% which compares well to the DAC performance.

In other words, you may need to upgrade your amplifier to get better sound quality. By the way, Ultra-LD kits are currently on sale at Altronics ($200 off) but be warned, building it is a lot of work.

SD card speech recorder problem

I purchased an Altronics kit for the SD Card Speech Recorder and am having problems with the recorder recognising files on the SD card correctly. When the recorder boots up from power on the version number is 2.40. I get a message that the card size is 992MB (for a 1GB flash card) and the free space is 0.0MB. I have one 7.7MB file called "rec001.wav" and one 1kB file called 'trigger.txt'.

A subsequent message is "Normal Configuration" which from my interpretation of the instructions is wrong because I have a "trigger.txt" file. The final screen display is: >[..]

I have tried two different memory cards – one 512MB and one 1GB, both formatted as FAT32 – and I get the same results with both cards. The recorder seems to respond to some key presses (on board) in that it will try to record a new file but I cannot convince it to play the pre-recorded file. In my application, I intend to play a pre-recorded audio file when triggered. (D. C., Morphett Vale, SA).

● Firstly, there is a new version of the firmware, 2.60, which you can download from the SILICON CHIP website. It fixes a problem with prior versions to do with reading and writing from and to 2GB SD cards.

If the free space is shown as 0.0 that indicates that the microcontroller cannot read-write to the memory card properly. This is also why the normal configuration is chosen, because the microcontroller cannot read the card properly so cannot detect the presence of the trigger.txt file. These problems all stem from the same problem; the fact that the microcontroller cannot read the memory card properly.

This could be due to: (1) a particular incompatibility with that SD card. Try a different card; (2) a hardware problem with accessing the card. Check the connections to the memory card connector and continuity between it

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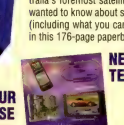

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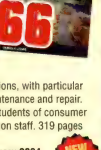

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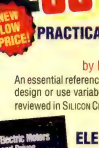

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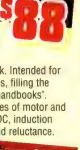

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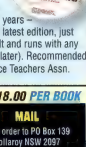

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Vintage Radio – continued from page 94

quite easily adjust the maximum tuned frequency to 1650kHz.

That done, I adjusted the antenna trimmer (19) at the high-frequency end of the dial for best performance. The performance at the low-frequency end now left a bit to be desired and this was fixed by tuning to that end of the dial and adjusting the padder capacitor (17). The adjustments at both ends were then repeated a few more times, by which time this little receiver was performing quite well.

With the alignment completed, the chassis was then slid back into its cabinet so that we could check the dial-scale calibration. The dial scale in this set is attached to the cabinet instead of to the chassis as in most sets. In practice, it's simply a matter of checking the calibration, then removing the chassis and sliding the pointer along the dial cord (about 20mm in this case) until the indicated station matches the tuned frequency.

The restoration was now completed by lightly oiling the slider (the rail that carries the pointer) and the tuning-gang bearings before finally securing the chassis inside the cabinet and attaching the back.

Summary

The Astor DL is an attractive, if rather heavy, austerity receiver which was manufactured just after World War II. It's quite a good performer – much better than you would expect of an austerity model – and is easy to work on. However, care is needed to ensure that you don't come into contact with the mains terminals under the chassis when servicing the set (it would be a good idea to insulate these).

This wasn't a particularly common model and as such, it is well worth having in a collection. SC

Ask SILICON CHIP – continued from page 98

and the microcontroller lines, or (3) a firmware issue.

Now (1) is unlikely since you've had the same problem with other cards too. (2) is possible, so check the PC board thoroughly to rule this out. Check the voltage to the memory card and check that the memory cards are formatted correctly. Finally, while (3) is possible, the firmware was tested with a number of different cards and many readers have now built the kit and it worked for them.

Turbo timer set-up problem

I built a Turbo Timer kit as described in November 1998 and set it up to keep the thermo fan running in our prototype amphibious vehicle after the engine is turned off. The fan still operates with the ignition on but won't run when the ignition is turned off. The engine reaches running temperature but the fan still cuts out when the engine is switched off. I have tried disconnecting the temperature sensor and that didn't work.

I have sent you a diagram of how it it is wired. Can someone please have a look at it and see if I have set it up wrong? (S. O., via email).

● We checked the wiring from the diagram you sent and that wiring is correct. In some cars, the triggering circuit on the Turbo Timer needs to be altered so as to trigger it at the time the ignition is switched off.

A 100Ω 5W resistor can be placed between contact 30 of relay 1 and ground. This discharges the ignition supply voltage if it is held high via capacitance. The resistor will run quite warm and will need to be housed appropriately away from wiring and plastics. It can be mounted against a metal section of the vehicle.

Also the 2.2μF capacitor at the pin 2 trigger input to IC1 on the Turbo Timer may need to be increased to give a sufficient trigger pulse with the ignition switched off. Try a value of 100μF instead. SC

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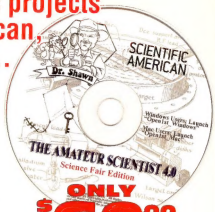

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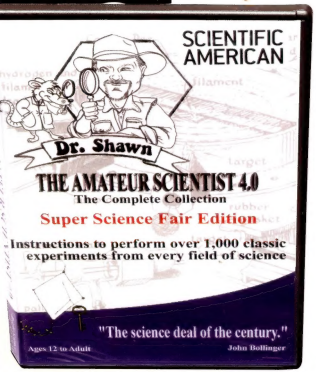

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